NASA TECHNICAL NOTE

NASA TN D-7236

NASA TN D-7236

NOISE TESTS OF A MIXER NOZZLE - EXTERNALLY BLOWN FLAP SYSTEM

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION • WASHINGTON, D. C. • MAY 1973

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
NASA TN D-7236		

4. Title and Subtitle	5. Report Date
NOISE TESTS OF A MIXER NOZZLE - EXTERNALLY BLOWN FLAP SYSTEM	May 1973
	6. Performing Organization Code

7. Author(s)	8. Performing Organization Report No.
Jack H. Goodykoontz, Robert G. Dorsch, and Donald E. Groesbeck	E-7288
	10. Work Unit No. 741-89

9. Performing Organization Name and Address	11. Contract or Grant No.
Lewis Research Center National Aeronautics and Space Administration Cleveland, Ohio 44135	

12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
National Aeronautics and Space Administration Washington, D.C. 20546	Technical Note
	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

Noise tests were conducted on a large-scale model of an externally blown flap lift-augmentation system, employing a mixer nozzle. The mixer nozzle consisted of seven flow passages with a total equivalent diameter of 40 centimeters. With the flaps in the 30°-60° setting, the noise level below the wing was less with the mixer nozzle than when a standard circular nozzle was used. At the 10°-20° flap setting, the noise levels were about the same when either nozzle was used. With retracted flaps, the noise level was higher when the mixer nozzle was used.

17. Key Words (Suggested by Author(s))	18. Distribution Statement
Acoustics; Aerodynamic noise; Aircraft noise; Jet aircraft noise; Lift augmentation; Noise (sound); Nozzles; Short takeoff aircraft; Wing flaps	Unclassified - unlimited

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price*
Unclassified	Unclassified	55	$3.00

* For sale by the National Technical Information Service, Springfield, Virginia 22151

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SUMMARY

Noise tests were conducted on a large-scale model of an externally blown flap lift-augmentation system, employing a mixer nozzle. The mixer nozzle consisted of seven flow passages with a total equivalent diameter of 40 centimeters. The wing model had a chord length of 2.08 meters and a span of 2.74 meters. The two wing flaps were placed in three different settings: (1) leading flap 30° from the wing chord line, trailing flap 60° from the wing chord line; (2) leading flap 10° from the chord line, trailing flap 20°; and (3) both flaps at 0° angle with respect to the wing chord line (i.e., retracted).

Noise data were taken for a range of nozzle exhaust velocities from 172 to 284 meters per second for the three flap settings. At the 30°-60° flap setting, overall sound pressure level under the wing (85° from engine inlet) was 4.5 dB less with the mixer nozzle than when a standard circular nozzle was used. At the 10°-20° flap setting, the noise levels were about the same when either the mixer or standard nozzle was used. With retracted flaps, the noise level was higher (1 to 2 dB) when the mixer nozzle was used. High-frequency noise levels were greater when the mixer nozzle was used, either alone or with the wing, compared to the results obtained from a standard nozzle. The standard nozzle had higher levels of low-frequency noise.

Perceived noise levels below the wing were greater for the mixer nozzle at the 10°-20° or retracted flap setting than when a standard nozzle was used. With the flaps in the 30°-60° setting, the perceived noise level with the mixer nozzle was less.

INTRODUCTION

This report summarizes the experimental results of the noise suppression capability of a mixer-type nozzle used with a model of an externally blown flap (EBF) lift-augmentation system. The EBF system is one of the methods proposed for use with STOL aircraft. The aerodynamic characteristics of this system are presented in references 1 and 2. An objectionable feature of this system is the additional noise, over

that of the jet alone, generated by the interaction of the jet with the trailing flaps, which are immersed directly in the engine exhaust. Results with conventional nozzles (refs. 3 to 5) showed that the jet-exhaust and deflected-flap interaction noise must be suppressed to meet STOL aircraft noise goals (95 EPNdB at 152.4 m). For example, estimates made in reference 3 for a hypothetical full-size STOL aircraft showed that, on takeoff, flyover perceived noise levels at 152.4 meters could be as much as 21 dB greater than the 95 EPNdB goal.

A mixer-type nozzle consists of an array of multielement flow passages rather than a single nozzle with one large flow passage. The purpose of the mixer nozzle is to cause rapid decay of the jet exhaust velocity by increased mixing with the surrounding air prior to reaching the flap station, so that the noise generated by the jet impinging on the flap surfaces is reduced to acceptable levels.

An experimental program to evaluate mixer nozzle exhaust decay characteristics is being conducted at the Lewis Research Center (e.g., refs. 6 and 7). The particular nozzle configuration employed in the noise tests of this report was judged to be the most suitable at the time the work reported herein was undertaken. Small-scale EBF noise tests with a multielement orifice, grossly similar to the configuration used herein (ref. 8), showed a reduction in noise level when compared to the results of a single orifice of the same area and operating at the same conditions (i.e., a 6-dB reduction in overall sound pressure level at 90° from the engine inlet when the wing flaps were in the 30°-60° setting). Therefore, a large-scale model that more closely simulated a real nozzle was fabricated and tested. The test nozzle was not optimized aerodynamically since it was felt that the external drag characteristics of the nozzle have little effect on the noise generated by an EBF system during static tests.

This report presents the experimental results obtained from the large-scale mixer nozzle and EBF model. The data were obtained for various flap angle settings and nozzle pressure ratios (1.2 to 1.7, corresponding to nozzle exhaust velocities from 172 to 284 m/sec). Comparisons are made between the results of the mixer nozzle and those obtained with a "standard" circular single convergent nozzle.

The large- and small-scale EBF models are compared in appendix B. (Symbols are defined in appendix A.)

The mixer nozzle equivalent diameter was 40 centimeters, giving a total exit area of 1255 square centimeters. The wing section with flaps retracted had a chord length of 2.08 meters and a span of 2.74 meters.

APPARATUS

Airflow System

The airflow system is shown in figure 1. Dry cold air (280 to 300 K) was supplied to the 40.6-centimeter gate shutoff valve by a 61-centimeter-diameter underground pipe from the Center's air supply system (1 MN/m^2 gage max.). The airflow rate and nozzle pressure ratio (nozzle total pressure divided by ambient atmospheric pressure) were set by adjustment of the 25.4-centimeter butterfly-type flow control valve.

Mufflers downstream of the flow control valve in the regions indicated in figure 1 were used to attenuate internal noise. The attenuators consisted of perforated plates and dissipative-type mufflers. The first perforated plate, located immediately downstream of the flow control valve, consisted of a 40.6-centimeter-diameter pipe cap with a series of 2.54-centimeter-diameter holes drilled in the cap to give an open area of approximately 40 percent. Two additional perforated plates were located at the entrance and exit of the first dissipative muffler (fig. 1). Each of the latter plates contained a series of 0.32-centimeter-diameter holes to give an open area of 20 percent in each plate.

The first dissipative muffler was a pipe 91.5 centimeters in diameter and 183 centimeters long that contained crossed splitter plates that divided the flow into four channels. All inside surfaces, including the surfaces of the splitter plates, were lined with a 2.54-centimeter-thick layer of hair felt held in place by 70-percent-open metallic sheets (expanded metal). The second dissipative muffler was basically the same as the first muffler, except that the adsorbent material was plastic felt. It was positioned in the air line immediately downstream of the last 45° elbow to take advantage of the multiple reflections associated with the flow turn.

In addition, the flow system was wrapped externally with fiberglass and leaded vinyl sheet to reduce the radiation of noise transmitted through the pipe wall.

Two screens (0.8-cm mesh) were placed in the air line downstream of the last muffler to improve the flow distribution to the nozzle.

Wing-Flap System

The configuration and dimensions of the externally blown flap model are shown in figure 2. Figure 2(a) shows the wing and nozzle orientation. The wing section with the flaps retracted had a chord length of 2.08 meters and a span of 2.74 meters. The flaps could be placed in any of three positions relative to the wing chord line: (1) leading flap 30°, trailing flap 60°; (2) leading flap 10°, trailing flap 20°; and (3) zero angle (flaps retracted). The wing chord line was at a 5° angle of attack relative to the nozzle

centerline. The distance from the wing chord line to the nozzle centerline, measured at the nozzle exit, was 48.9 centimeters; and the leading edge of the wing was 17.8 centimeters ahead of the nozzle exit. The distance from the nozzle exit to the 60° flap, measured along the nozzle centerline, was 1.83 meters. The wing was mounted on the stand with the spanwise direction vertical. The nozzle centerline was 3.91 meters above grade and was located 1.52 meters from the spanwise bottom of the wing and 1.22 meters from the top. The off-center installation was incorporated to minimize interference with the support stand by spanwise flow on the flaps.

Figures 2(b) and (c) show the dimensions of the flap sections and their orientation relative to the fixed portion of the wing.

Figure 2(d) shows the test installation. The wing was equipped with leading-edge flaps that straddled the nozzle assembly. The trailing flaps were held in position, relative to the wing, by five 0.0985-centimeter-thick steel plates - one at each end of the wing and three spaced as shown in figure 2(d). The guy wires shown in the figure did not interfere with the airflow from either the nozzle or the trailing flap. The vertical pipe to the upper right of figure 2(d) was the air supply line for the reference orifice (see PROCEDURE).

Mixer Nozzle

The configuration and dimensions of the mixer nozzle are shown in figure 3. The nozzle consisted of four straight lobes alternated with four lobes that were canted 10° outward from the nozzle centerline. The canted lobes accelerated the velocity decay (ref. 6). The exit area of the nozzle lobes was reduced by about 20 percent from the upstream portion of the lobe. The total exit area of the eight-lobe nozzle was 1438 square centimeters. An elliptical centerbody was placed upstream of the lobes to improve the flow coefficient of the nozzle. A comparison of actual flow rate to ideal flow rate showed that the ratio was about 0.99.

The position of the mixer nozzle relative to the wing is shown in figure 4. Initially, the nozzle was operated as an eight-lobe nozzle (all lobes open) and oriented so that a straight lobe was closest to the underside of the wing. However, preliminary tests with this configuration and the wing flaps in the 30°-60° position showed that only a slight reduction in flap interaction noise was achieved, compared to flaps blown by a standard single convergent nozzle. It was found that intense wing scrubbing occurred as a result of the air jet from the closest lobe being located so near the wing. Therefore, the distance from the wing to the nearest lobe was increased by rotating the nozzle and blocking one canted lobe, as shown in figure 4. The total exit area of the seven-lobe nozzle was 1255 square centimeters. Again, a comparison of the actual flow rate through the seven-lobe nozzle to the ideal flow rate showed that the ratio was about 0.99.

Instrumentation

The noise data were measured by twenty 1.27-centimeter-diameter condenser microphones placed at various intervals on a 15.24-meter-radius circle around the wing-nozzle setup (fig. 5). The center of the microphone circle was located on the nozzle centerline halfway between the nozzle exit and the intersection with the 60° flap. The microphone circle was in a horizontal plane 3.91 meters above an asphalt surface and perpendicular to the vertically mounted wing. Windscreens were placed on all microphones. A standard piston calibrator (124(±0.2)-dB, 250-Hz tone) was used to calibrate the condenser microphones. The noise data were analyzed by a 1/3-octave-band spectrum analyzer which determined sound pressure level spectrums referenced to 2×10^{-5} N/m^2.

Airflow rate was measured by an orifice flowmeter located in a straight section of the underground air supply line upstream of the gate shutoff valve. Pressure drop across the orifice flowmeter and static pressure upstream of the flowmeter were measured by strain-gage pressure transducers. Strain-gage pressure transducers were also used to measure total and static pressure upstream of the nozzle. Total pressures downstream of the nozzle, in the free jet stream (with wing removed), were measured by a single strain-gage transducer manifolded to a multitube total pressure rake by way of a manual stepping mechanism. All pressures were recorded on strip-chart instruments. Temperatures were measured upstream of the flow orifice and test nozzle by thermocouples immersed in the flow stream.

Weather data (barometer, temperature, humidity, wind speed and direction) were also monitored and/or recorded.

PROCEDURE

Free jet stream velocities with the wing removed were calculated from total pressures measured downstream of the seven-lobe nozzle. Total pressure surveys were made across two diametrically opposed straight lobes and two opposed canted lobes. The static pressure in the free jet stream was assumed to be atmospheric, and the total temperature was assumed to be the same as the temperature measured upstream of the nozzle.

Far-field noise data were taken for various pressure ratios across the test nozzle. The test procedure was to obtain a steady flow condition for a given total pressure upstream of the nozzle. Noise data were then taken at each microphone location in succession. After three complete cycles the airflow rate was changed and the process repeated. The three samples of noise data at each microphone were averaged and

corrected for atmospheric attenuation (a function of frequency, temperature, and relative humidity) to give lossless sound pressure level (SPL) data at 15.24 meters. From the sound pressure level spectra, the overall sound pressure levels (OASPL) were calculated at each microphone location. The data presented herein do not include ground reflection corrections. It was estimated in reference 3 that the ground reflections increased the overall sound pressure level by about 1.5 dB at the selected microphone locations.

All instrumentation was calibrated before each run and checked after the run. The overall sound data acquisition system was checked for repeatability by flowing air through a reference orifice located near the center of the microphone circle, analyzing the emitted sound, and examining the data to see if the results obtained from the current run agreed with a previous run.

Sideline noise measurements were made with the mixer nozzle and the flaps in the 30°-60° position. This was done by suspending a microphone 15.24 meters above the center of the microphone circle from the boom of a mobile crane. Only one microphone was placed on the standard microphone circle for these tests - at 85° from the engine inlet.

RESULTS AND DISCUSSION

Peak Velocity Decay

Velocity profiles downstream of the seven-lobe mixer nozzle, with the wing removed, are shown in figures 6 and 7. Figure 6 shows the velocity profiles across the straight lobes of the nozzle at three axial positions and three different nozzle pressure ratios, or exhaust velocities. Near the exit, figure 6(a), the flow field has two separate profiles with zero velocity near the axis of the nozzle. At the distance shown in figure 6(a), X = 50.8 centimeter (all symbols defined in appendix A), the peak velocity is approximately equal to the nozzle exhaust velocity for all nozzle pressure ratios shown.

At an axial distance of 183 centimeters, figure 6(b), the flow field still shows the influence of each individual jet from the nozzle, as indicated by the double peak in the profile. This axial distance (183 cm) is the same distance as that from the nozzle exit to the 60° flap, measured along the nozzle axis, when the wing is in place. The peak velocity for a nozzle pressure ratio of 1.7 has decreased to 67 percent of the nozzle exhaust velocity. For nozzle pressure ratios of 1.5 to 1.3 the peak velocity has decreased to 63 and 60 percent of the exhaust velocity, respectively. The profiles are asymmetric about the nozzle centerline as a result of the asymmetry of the seven-lobe nozzle configuration. At an axial distance of 244 centimeters, figure 6(c), the jet is

still in the development stage since the flow characteristics of each nozzle element are easily identified.

Figure 7 shows velocity profiles across the canted lobes of the seven-lobe mixer nozzle (with the wing removed) at a distance of 183 centimeters downstream of the nozzle exit. The profiles are characterized by four peaks, as compared to two peaks obtained across the straight lobes. In addition, the peak velocity from the canted lobe is less than that from the straight lobe, at the same axial distance and nozzle exhaust velocity. The total width of the jet from the canted lobes is approximately 75 percent greater than the jet from the straight lobes (X = 183 cm). The increased area of jet impingement on the flaps is detrimental since flap impingement noise is proportional to the area of impingement.

Results of the velocity decay measurements for the mixer nozzle (with the wing removed) are summarized in figure 8. The ordinate is the ratio of the local peak velocity V (for a straight lobe) to the velocity at the exit of the nozzle V_j. (For similar conditions, the straight-lobe peak velocity was greater than that from a canted lobe.) The velocity ratio is plotted as a function of an axial distance parameter which includes the axial distance downstream of the nozzle exit X, the total equivalent diameter of the nozzle D_{et}, the nozzle discharge coefficient C_e, and the Mach number of the jet at the orifice exit M_j. The total equivalent diameter D_{et} for the seven-lobe mixer nozzle was 40 centimeters. The solid curve in figure 8 is representative of the velocity decay results obtained with circular single-element nozzles (ref. 6). Data for a 33-centimeter-diameter standard circular nozzle (ref. 3) and a 6.1-centimeter-diameter orifice (ref. 6) are also presented for comparison. As shown in the figure the mixer nozzle gives a faster rate of velocity decay downstream of the exhaust plane than a single-element nozzle. For example, at an axial distance parameter value of 4.8 the mixer nozzle local peak velocity is about 53 percent of the nozzle exhaust velocity. The local peak velocity for a single-element nozzle at the same condition is still above 90 percent of the nozzle exhaust velocity.

Sound Measurements

Tabulation of data. - The sound data are given in table I. The data are presented in terms of 1/3-octave-band sound pressure levels at 15.24 meters from the center of the microphone circle and at various angles from the engine inlet. An angle of 85° would be normal to and below the wing. The sound pressure levels (SPL) were corrected for atmospheric attenuation so that the tabulated levels are lossless at a distance of 15.24 meters from the center of the microphone circle. The overall sound pressure level (OASPL) at a given angle is also tabulated. The data are presented for a range of

nozzle pressure ratios (or nozzle exhaust velocities) and wing flap settings. Data for the nozzle alone are also presented.

Mixer nozzle alone. - Results of the sound measurements for the seven-lobe mixer nozzle alone are shown in figure 9. In figure 9(a) the overall sound pressure level directivity is shown at a radius of 15.24 meters at various nozzle pressure ratios (nozzle exhaust velocities). The directivity is symmetrical about the nozzle centerline with the peak OASPL occurring at 135° (and 215°) from the engine inlet (air supply line). A decrease in the level occurs as the exhaust velocity decreases. In figure 9(b) the sound pressure level 1/3-octave spectra are shown at 85° from the engine inlet for nozzle pressure ratios of 1.7 and 1.3. The spectra are broadband with a rapid rate of decrease in SPL above 10 kilohertz. Figure 9(c) shows a comparison of the spectra for two nozzle pressure ratios at the peak OASPL position, 135° from the engine inlet. Again, the spectra are broadband but, compared to the 85° position, have a higher SPL up to a frequency of 10 kilohertz. Above 10 kilohertz the data at the two angular positions are similar.

The variation of total sound power level with nozzle exhaust velocity for the nozzle alone is shown in figure 10. The data show that the total sound power varies as the eighth power of the nozzle exhaust velocity.

Mixer nozzle with wing. - Results of the noise measurements for the seven-lobe mixer nozzle with the wing at various flap settings are shown in figure 11. Data for the nozzle without the wing are also shown. All data are for a nozzle pressure ratio of 1.7; the trends are similar for the other pressure ratios that were tested. Figure 11(a) shows the overall sound pressure level directivity at a radius of 15.24 meters. A large increase in noise level occurs below and forward of the wing (up to 6 dB from zero to 90°) as the flaps are lowered from the retracted position to the 30°-60° position. In addition, the noise radiation pattern is altered. For example, with the flaps retracted the peak OASPL occurs at 135° from the engine inlet, whereas with the flaps at the 30°-60° setting the peak OASPL occurs at 70°. The increase in noise level (zero to 90°) is a result of two factors: (1) redirection of nozzle noise, and (2) impingement noise caused by lowering the flaps into the jet exhaust. The redirection of the nozzle noise is illustrated by noting in figure 11(a) that the noise below the wing, with the retracted flap setting, is greater than that for the nozzle alone. Conversely, above the wing the noise is less than that for the nozzle alone.

The sound pressure level (SPL) spectra at 85° from the engine inlet are shown in figure 11(b). The figure shows that lowering the flaps into the jet exhaust causes an increase in the sound level in the low-frequency region of the spectra.

The variation of peak OASPL with nozzle exhaust velocity for the wing with the flaps and for the nozzle alone is shown in figure 12. Note that the angular position of the peak OASPL varies with the configuration being tested (fig. 11(a)). With the wing flaps in the

30°-60° and 10°-20° positions, the peak OASPL varies as the exhaust velocity to the seventh power. For the retracted flap configuration, and also for the nozzle alone, the peak OASPL follows an eighth-power relation.

Figure 13 shows the variation in the peak OASPL with flap impingement velocity for the 30°-60° and 10°-20° flap settings. The flap impingement velocity was taken as the peak velocity from the free-jet-stream velocity profile measured at 183 centimeters downstream from the nozzle exit (e.g., fig. 6(b)). The figure shows that the peak OASPL varies as the sixth power of the flap impingement velocity. Also there is approximately a 2-dB separation in level between the two configurations for a given velocity.

Comparison Between Mixer Nozzle and Standard Convergent Nozzle

Comparisons of noise data for the mixer nozzle and a standard circular nozzle, both alone and with the wing, are shown in figures 14 to 17. Data for the standard nozzle alone and with the wing in place were taken during the study reported in reference 3. The standard nozzle had a 33-centimeter-diameter circular exhaust. The data from the standard nozzle were scaled up to the mixer nozzle size by the method outlined in reference 3.

Comparisons of the data for the nozzles alone are shown in figure 14. Figure 14(a) shows that the mixer nozzle has a larger OASPL than the standard nozzle at nearly all angular positions for both nozzle pressure ratios. The SPL 1/3-octave spectra for the nozzles are compared in figure 14(b). As shown, the mixer nozzle contains higher levels of high-frequency noise, which is characteristic of multielement nozzles.

Figure 15 shows a comparison of the data for the nozzles used with the wing and the 30°-60° flap position. The OASPL, figure 15(a), shows that the standard nozzle configuration has a greater sound level for all angles from the engine inlet. The small difference between nozzle exhaust velocities would attribute only a 0.7-dB increase in the noise level of the mixer nozzle and wing configuration (fig. 12). Free-stream velocity measurements for the standard nozzle presented in reference 3 showed that the flap impingement velocity was almost the same as the nozzle exhaust velocity; whereas, the impingement velocity with the mixer nozzle was approximately 65 percent of the exhaust velocity. However, the reduction in noise level, as a result of the lower impingement velocity, is partially offset by the larger impingement area that occurs when the mixer nozzle is used. The SPL spectra for the two nozzles at 85°, figure 15(b), show that the mixer nozzle and flap system at high frequency is slightly noisier.

The data for the nozzles blowing on the 10°-20° flaps are shown in figure 16. The OASPL, figure 16(a), shows very little difference below the wing, between zero and

140^{o}, for the two nozzle configurations. Above the wing, 195^{o} to 340^{o}, lower noise levels were measured when the mixer nozzle was used. The SPL spectra at 85^{o} from the engine inlet are shown in figure 16(b). With the mixer nozzle the noise level is lower in the low-frequency portion of the spectra. In the high-frequency range the mixer nozzle configuration has the higher noise level.

With the flaps in the retracted position, the OASPL with the mixer nozzle is slightly greater under the wing, figure 17(a). The SPL spectra, figure 17(b), again show that the mixer nozzle has a lower level in the low-frequency end of the spectra and a higher sound level in the high-frequency end.

Perceived noise levels. - Perceived noise level (PNL) calculations at 152.4 meters were made for the seven-lobe mixer and standard nozzles alone, and also for the nozzles blowing on the wing-flap system. The method of making the PNL calculations is given in reference 9. Attenuation losses due to atmospheric absorption and spherical spreading were taken into consideration for the PNL's. The results of the calculations are shown in figures 18 to 21. Figure 18 shows the comparison for the two nozzles alone at two different nozzle pressure ratios, or nozzle exhaust velocities. The mixer nozzle has a higher PNL for all angles from the engine inlet as a result of the higher sound level in the high-frequency portion of the spectrum (fig. 14(b)). Figure 19 shows the comparison for the two nozzles blowing on the wing at the 30^{o}-60^{o} flap setting. Under the wing (zero to 100^{o}), the PNL is from 2 to 4 PNdB lower with the mixer nozzle than when the standard nozzle is used, at a nozzle pressure ratio of 1.7. At a pressure ratio of 1.3 the difference in PNL is from 2 to 7 PNdB (zero to 100^{o}).

The PNL's for the nozzles blowing on the 10^{o}-20^{o} flaps are shown in figure 20. For both pressure ratios the PNL is 1 or 2 PNdB greater for the mixer nozzle than for the standard nozzle from 70^{o} to 145^{o} from the engine inlet. Figure 21 shows the PNL's for the nozzles used with the retracted flap setting. Again, the mixer nozzle gives a higher PNL under the wing. In terms of perceived noise level, the high-frequency characteristics of the mixer nozzle become detrimental when the nozzle is used with the wing flaps in the 10^{o}-20^{o} and retracted settings.

The variation of perceived noise level at 152.4 meters with nozzle exhaust velocity is shown in figures 22 to 24. Perceived noise levels are given for the various wing flap settings and for the nozzle alone and also at different angles from the engine inlet. Figure 22(a) shows the variation of PNL at a typical location under the wing, 85^{o} from the engine inlet. Also plotted in the figure are PNL's for the standard nozzle. As discussed earlier, the PNL's for the mixer nozzle are shown to be greater than those for the standard nozzle for all configurations except the 30^{o}-60^{o} flap setting. Best-fit curves drawn through the data points indicate that the PNL at 85^{o} from the engine inlet varies as the eighth power of the nozzle exhaust velocity.

Figure 22(b) shows the variation of PNL at 152.4 meters with nozzle exhaust velocity at a microphone location that would correspond to a position beneath an airborne aircraft, where a maximum in noise level would occur during flyover. The figure shows less difference in PNL's for the various configurations than was shown at the 85° position. However, the variation of PNL with exhaust velocity for the nozzle alone follows a ninth-power relation.

Figure 23 shows the variation in peak PNL at 152.4 meters with nozzle exhaust velocity. The peak PNL location does not, in all cases, occur at the flyover maximum position of figure 22(b). Figure 23 shows very little difference in peak PNL when the flaps are in the deflected positions (30°-60°, 10°-20°). The peak PNL for the deflected flaps is approximately 2 PNdB higher than that for the retracted flaps, at a given velocity. The variation of peak PNL with exhaust velocity for the nozzle and wing configurations is an eighth-power relation. The peak PNL for the mixer nozzle alone varies approximately as the ninth power of the exhaust velocity.

The variation of peak PNL with flap impingement velocity is shown in figure 24. The peak PNL for the flaps in the 30°-60° setting varies as the impingement velocity to the 7th power, whereas for the 10°-20° setting the relation is closer to the 6.5 power.

Sideline noise levels. - The results of the sideline noise tests with the flaps in the 30°-60° position are shown as SPL 1/3-octave spectra in figure 25 and are compared with the spectra below the wing at 85° from the engine inlet. All spectra contain the actual SPL data at 15.24 meters from the center of the microphone circle (atmospheric and spherical spreading attenuation are present). The levels below the wing are higher at all frequencies than those at the sideline for both nozzle pressure ratios. The OASPL at 15.24 meters and the PNL at 152.4 meters are also given in the figure. The OASPL below the wing is from 5 to 6 dB higher than that at the sideline. For the PNL calculations the additional attenuation caused by atmospheric absorption and spherical spreading was taken into consideration. The PNL is shown to be from 5 to 7 PNdB greater below the wing than at the sideline.

SUMMARY OF RESULTS

The results of the noise tests with a specific externally blown flap configuration with a mixer-type nozzle blowing on various settings of the wing flaps can be summarized as follows:

1. A comparison between the overall sound pressure level (OASPL) at 15.24 meters under the wing at 85° from the engine inlet with the mixer nozzle and that when a standard circular nozzle is used showed the following results:

   a. With the 30°-60° flap setting, the mixer nozzle configuration was 4.5 dB quieter.

b. With the 10^{o}-20^{o} flap setting, there was no difference.

c. With the retracted flap setting, the mixer nozzle configuration was 1.5 dB noisier.

2. A comparison between the sound pressure level (SPL) spectra for the mixer nozzle and a standard circular nozzle, both alone and with the wing, showed that the mixer nozzle configuration had higher levels of high-frequency noise and lower levels of low-frequency noise.

3. The perceived noise levels (PNL's) at 152.4 meters at 85^{o} from the engine inlet for the mixer nozzle alone and with the flaps in the 10^{o}-20^{o} and retracted settings were from 1 to 3 PNdB greater than those using a standard nozzle. The PNL at the same distance and location for the 30^{o}-60^{o} flap setting was 3.5 PNdB less when the mixer nozzle was used.

4. The noise data showed the following dependence on nozzle exhaust velocity:

a. The total sound power of the mixer nozzle alone varied as the eighth power of the exhaust velocity.

b. Peak OASPL at 15.24 meters varied as the seventh power of nozzle exhaust velocity when the flaps were in the 30^{o}-60^{o} and 10^{o}-20^{o} positions. With the flaps retracted, and also with the nozzle alone, the peak OASPL varied as the eighth power of exhaust velocity.

c. Peak PNL's at 152.4 meters varied as the eighth power of mixer nozzle exhaust velocity for the wing flaps in all positions.

5. The noise data showed the following dependence on flap impingement velocity:

a. Peak OASPL at 15.24 meters varied as the sixth power of flap impingement velocity when the flaps were in the 30^{o}-60^{o} and 10^{o}-20^{o} positions.

b. Peak PNL's at 152.4 meters varied as the 6.5 power of flap impingement velocity when the flaps were in the 10^{o}-20^{o} setting. When the flaps were in the 30^{o}-60^{o} setting the peak PNL varied as the impingement velocity to the seventh power.

6. Lowering the flaps from the retracted to the 30^{o}-60^{o} position increased the OASPL below the wing (zero to 90^{o}) by as much as 6 dB. In addition, the noise radiation patterns were altered; for example, the peak OASPL occurred at 70^{o}, 125^{o}, and 135^{o} from the engine inlet when the flaps were in the 30^{o}-60^{o}, 10^{o}-20^{o}, and retracted settings, respectively.

7. Sideline OASPL at 15.24 meters was from 5 to 6 dB lower than that under the wing at 85^{o} from the engine inlet (flaps at the 30^{o}-60^{o} setting).

8. A faster rate of free-jet-stream velocity decay was obtained with the mixer nozzle than with a standard nozzle. With both nozzles operating under the same conditions, the mixer nozzle reduced the nozzle exhaust velocity to 53 percent of its original value

compared to a 10-percent reduction obtained from a standard nozzle at the same distance downstream of the nozzle exit.

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Cleveland, Ohio, January 17, 1973,
741-89.

APPENDIX A

SYMBOLS

C_e	nozzle discharge coefficient
D_{et}	equivalent diameter = $\sqrt{\frac{4(\text{Total area})}{\pi}}$
M_j	Mach number at nozzle exit
OASPL	overall sound pressure level referenced to 2×10^{-5} N/m^2, dB
PNL	perceived noise level, PNdB
SPL	sound pressure level referenced to 2×10^{-5} N/m^2, dB
V	free-stream peak jet velocity, m/sec
V_j	peak velocity at nozzle exit, m/sec
X	axial distance from nozzle exit, m

APPENDIX B

COMPARISON BETWEEN LARGE-SCALE AND SMALL-SCALE EXTERNALLY BLOWN FLAP MODELS USED WITH MIXER NOZZLE

Preliminary tests of the mixer nozzle concept for reducing blown flap noise were reported in reference 8. In that work a small-scale externally blown flap model was used. The mixer nozzle was simulated by using an eight-lobe orifice to obtain rapid exhaust velocity decay. The equivalent diameter of the eight-lobe orifice was 5.95 centimeters. The small-model data were scaled up to the large-model data by applying the scaling laws reported in reference 3.

Figure 26 shows a comparison of the noise data obtained from the orifice model alone and the nozzle alone. The exhaust velocities at the exit were approximately the same for both devices. The OASPL, figure 26(a), shows fair agreement considering the magnitude of the scaling factor (ratio of equivalent diameters is 6.73), the difference in the configuration of the orifice plate and the highly efficient nozzle, and the fact that two entirely different facilities were used to obtain the data. The SPL spectra, figure 26(b), show good agreement over the range of available data.

The noise data for the nozzle and the orifice model blowing on the 30°-60° flaps are shown in figure 27. Again, the agreement is considered good. The noise data for the 10°-20° and zero flap positions were also in good agreement.

REFERENCES

1. Parlett, Lysle P.; Freeman, Delma C., Jr.; and Smith, Charles C., Jr.: Wind-Tunnel Investigation of a Jet Transport Airplane Configuration with High Thrust - Weight Ratio and an External-Flow Jet Flap. NASA TN D-6058, 1970.

2. Freeman, Delma C., Jr.; Parlett, Lysle P.; and Henderson, Robert L.: Wind-Tunnel Investigation of a Jet Transport Airplane Configuration with an External-Flow Jet Flap and Inboard Pod-Mounted Engines. NASA TN D-7004, 1970.

3. Dorsch, R. G.; Kreim, W. J.; and Olsen, W. A.: Externally-Blown-Flap Noise. Paper 72-129, AIAA, Jan. 1972.

4. Dorsch, R. G.; Krejsa, E. A.; and Olsen, W. A.: Blown Flap Noise Research. Paper 71-745, AIAA, June 1971.

5. Olsen, William A.; Dorsch, Robert G.; and Miles, Jeffrey H.: Noise Produced by a Small-Scale, Externally Blown Flap. NASA TN D-6636, 1972.

6. Groesbeck, D.; Huff, R.; and von Glahn, U.: Peak Axial-Velocity Decay with Mixer-Type Exhaust Nozzles. NASA TM X-67934, 1971.

7. von Glahn, U. H.; Groesbeck, D. E.; and Huff, R. G.: Peak Axial-Velocity Decay with Single- and Multi-Element Nozzles. Paper 72-48, AIAA, Jan. 1972.

8. Goodykoontz, Jack H.; Olsen, William A.; and Dorsch, Robert G.: Small-Scale Tests of the Mixer Nozzle Concept for Reducing Blown-Flap Noise. NASA TM X-2638, 1972.

9. Anon.: Definitions and Procedures for Computing the Perceived Noise Level of Aircraft Noise. Aerospace Recommended Practice 865A, SAE, Oct. 1964.

TABLE I. - ONE-THIRD-OCTAVE-BAND SOUND PRESSURE LEVEL ON 15.24-METER-RADIUS CIRCLE

FOR EXTERNALLY BLOWN FLAP WITH SEVEN-LOBE MIXER NOZZLE

[Sound pressure level referenced to 2×10^{-5} N/m^2. Data corrected for atmospheric attenuation (lossless).]

(a) Run 1. Flap setting, 30°-60°; nozzle pressure ratio, 1.7; nozzle exhaust velocity, 289 m/sec; nozzle temperature, 294 K; ambient temperature, 294 K; relative humidity, 40 percent; barometric pressure, 101.3×10^3 N/m^2.

Frequency, Hz	Angle, deg																			
	10	25	40	55	70	85	100	105	155	170	185	200	215	230	250	270	290	310	330	350
	Sound pressure level, dB																			
50	90.7	93.0	92.8	92.7	93.3	92.7	90.3	90.2	89.0	90.0	91.0	91.7	92.7	93.2	91.7	90.2	88.5	86.3	87.5	87.8
63	93.3	94.3	94.8	95.0	95.2	93.7	91.3	91.0	90.2	91.0	91.8	92.5	93.5	93.0	92.7	91.5	90.3	88.2	88.3	91.0
80	94.2	94.7	96.8	96.0	95.2	93.2	90.7	90.5	90.2	92.0	91.7	92.5	92.7	92.2	91.5	91.8	90.3	88.7	89.7	91.5
100	94.0	94.7	96.7	95.2	93.2	92.4	89.9	89.9	91.7	93.8	95.0	95.0	95.2	93.7	93.5	92.0	92.4	89.7	89.9	91.7
125	99.5	100.0	101.0	99.7	97.7	95.2	93.9	93.0	96.7	99.8	100.4	101.2	100.7	100.0	97.5	96.0	95.5	95.2	95.2	96.4
160	102.7	104.4	104.4	102.7	101.2	100.0	97.9	96.9	101.0	103.9	103.7	103.9	104.2	104.2	102.5	98.9	98.0	98.7	98.7	100.0
200	104.9	106.4	105.0	104.2	105.2	102.7	101.4	100.7	101.9	104.7	105.4	105.0	105.0	103.9	102.4	100.7	98.2	99.0	101.0	102.5
250	104.5	105.9	105.5	105.5	105.9	104.2	101.7	101.0	100.0	103.9	104.5	103.9	102.2	101.4	99.9	99.5	98.4	99.0	100.5	101.9
315	102.9	103.7	103.7	103.4	103.7	102.6	100.7	100.9	100.7	104.1	102.7	101.9	101.1	98.9	97.7	96.9	97.2	98.1	99.7	99.9
400	102.6	104.4	104.6	104.6	105.7	105.4	103.7	102.4	100.9	103.9	104.1	102.6	101.7	100.9	99.9	99.6	98.6	98.1	98.6	99.7
500	101.8	103.9	105.4	105.4	106.6	104.9	103.1	102.3	97.3	102.1	101.4	99.9	99.3	98.9	98.3	96.8	96.3	96.3	96.3	99.4
630	100.1	102.9	104.0	105.1	105.4	103.9	102.6	101.6	96.6	101.4	101.3	99.6	99.3	98.8	98.1	96.6	95.9	95.8	96.3	96.9
800	100.5	102.6	104.1	104.8	105.0	103.0	102.0	102.0	96.8	101.0	100.6	99.5	99.3	98.3	98.5	97.1	96.8	95.5	96.1	96.0
1 000	99.5	101.8	103.3	104.3	103.7	103.0	102.3	101.8	96.5	100.2	100.2	99.0	98.5	98.2	98.0	97.0	96.3	95.0	95.3	95.0
1 250	98.7	101.7	102.7	103.1	103.7	102.6	102.1	101.6	95.6	99.2	99.9	98.6	98.2	98.4	96.7	96.1	95.6	94.6	95.2	95.7
1 600	97.5	100.8	101.8	101.8	102.3	102.0	101.5	100.3	94.3	98.3	98.5	97.6	97.3	97.3	95.5	94.5	94.0	92.5	94.1	94.1
2 000	96.5	100.2	100.9	101.0	100.7	101.4	101.4	99.5	92.5	96.4	96.9	95.9	96.5	95.9	94.4	92.7	91.7	90.7	93.2	92.7
2 500	94.3	97.8	99.8	99.9	100.6	100.3	100.8	100.6	90.9	95.6	96.4	95.3	94.9	94.3	94.1	91.3	90.3	91.1	90.9	91.4
3 150	94.7	98.2	99.7	101.1	102.2	100.4	101.2	101.7	92.1	96.4	97.4	96.1	95.1	94.2	92.1	91.4	90.6	91.6	90.9	92.1
4 000	95.1	98.6	99.6	100.4	100.7	101.1	100.9	99.4	91.1	95.4	95.2	93.9	94.1	92.4	89.7	90.4	89.7	89.1	90.9	91.7
5 000	93.6	96.7	97.2	98.6	98.6	100.6	99.9	98.6	88.7	92.6	91.9	91.1	90.9	90.2	89.9	87.9	86.9	87.4	88.9	87.9
6 300	89.8	93.1	95.3	97.0	98.3	98.5	98.1	98.5	89.0	91.0	92.6	90.8	88.8	89.6	88.6	87.6	86.1	86.8	86.3	86.8
8 000	89.6	92.9	94.8	96.8	97.9	98.1	97.6	97.6	88.3	90.4	89.9	88.4	88.9	88.3	86.9	85.8	84.9	85.3	86.6	86.1
10 000	87.5	90.6	93.1	95.3	97.1	96.8	97.0	96.8	87.1	88.0	89,1	88.3	87.3	87.0	86.5	85.3	84.3	84.6	84.8	84.6
12 500	85.6	88.6	90.4	92.7	94.7	95.7	95.4	95.9	85.2	85.8	87.7	86.2	84.2	84.4	84.6	82.6	81.6	82.2	81.7	82.2
16 000	81.4	84.7	87.7	89.9	92.4	92.9	92.9	93.4	82.4	84.6	85.4	83.7	82.9	81.7	82.0	79.9	78.9	79.5	79.7	79.0
20 000	78.3	81.3	84.1	86.6	88.6	89.6	90.1	90.6	79.6	80.3	82.4	80.6	79.3	78.6	79.9	76.8	75.3	76.3	75.9	76.1
Overall	113.2	115.2	115.8	115.8	116.2	115.2	114.2	113.6	110.3	112.7	113.8	113.1	112.7	112.0	110.8	109.4	108.5	108.3	109.3	110.3

TABLE I. - Continued. ONE-THIRD-OCTAVE-BAND SOUND PRESSURE LEVEL ON 15.24-METER-RADIUS CIRCLE FOR EXTERNALLY BLOWN FLAP WITH SEVEN-LOBE MIXER NOZZLE

[Sound pressure level referenced to 2×10^{-5} N/m^2. Data corrected for atmospheric attenuation (lossless).]

(b) Run 2. Flap setting, 30°-60°; nozzle pressure ratio, 1.5; nozzle exhaust velocity; 257 m/sec; nozzle temperature 299 K; ambient temperature, 294 K; relative humidity, 40 percent; barometric pressure 101.3×10^3 N/m^2.

Frequency, Hz	Angle, deg																			
	10	25	40	55	70	85	100	105	155	170	185	200	215	230	250	270	290	310	330	350
	Sound pressure level, dB																			
50	90.3	91.7	93.2	92.3	92.5	91.8	89.3	89.0	86.8	88.0	89.5	90.0	91.3	90.5	90.7	90.2	87.7	85.7	85.8	87.3
63	91.3	92.7	94.0	93.7	94.0	92.7	89.7	89.8	87.2	89.2	89.7	90.8	91.7	91.5	91.3	91.2	88.8	87.0	87.5	88.5
80	91.8	92.8	93.8	93.3	92.7	90.8	89.3	88.0	87.8	88.8	89.8	90.5	90.5	90.5	89.7	90.2	89.2	87.0	88.0	88.8
100	92.2	92.9	94.0	92.4	91.5	90.0	87.9	86.9	89.7	91.2	92.5	92.9	93.2	90.9	91.0	89.7	90.9	89.0	88.2	89.2
125	96.7	97.0	98.4	96.2	94.9	93.4	90.9	90.2	93.7	96.0	97.0	98.2	98.9	96.9	95.2	94.5	93.9	92.7	92.5	93.5
160	99.0	100.0	100.9	98.9	97.9	96.9	95.0	94.2	97.4	100.2	101.0	101.4	101.9	100.9	99.9	95.9	94.7	95.4	95.0	97.2
200	101.2	102.9	102.4	101.5	101.5	99.9	98.4	97.4	98.9	101.4	102.2	102.2	102.0	101.2	99.0	97.4	95.2	96.0	97.4	98.5
250	100.4	102.2	101.9	102.9	103.2	100.5	98.2	97.2	96.5	99.9	101.0	100.0	98.4	98.0	96.4	96.5	94.9	96.2	97.4	98.7
315	98.2	99.7	99.7	99.7	100.1	99.1	96.9	96.2	96.6	98.9	98.6	97.7	96.6	94.9	94.9	92.9	93.1	94.4	95.2	95.9
400	97.9	100.1	100.6	100.4	101.4	101.4	99.9	98.2	96.9	99.6	99.2	98.4	97.7	97.1	95.6	95.1	94.2	93.9	93.7	95.2
500	97.3	99.3	100.8	100.6	101.6	101.1	98.3	97.8	93.9	97.4	96.6	95.1	95.1	94.8	93.8	92.4	92.3	91.9	91.8	94.4
630	96.4	98.6	99.8	100.3	100.4	100.1	98.1	97.3	92.9	97.1	96.3	94.8	94.6	93.9	93.8	92.4	91.8	91.1	91.4	92.6
800	95.6	98.0	99.6	100.1	100.0	99.1	98.0	97.1	92.8	97.0	95.8	94.8	94.5	94.0	94.0	93.1	92.3	91.6	92.1	92.1
1 000	94.8	97.8	98.5	99.5	99.5	98.8	98.0	97.3	92.2	95.8	95.2	94.3	93.8	94.0	93.7	93.0	92.3	91.0	92.3	91.3
1 250	94.1	96.9	97.7	98.2	98.9	98.6	97.6	97.1	91.6	95.2	94.6	93.9	93.2	93.9	92.4	92.1	91.6	90.4	90.9	91.4
1 600	92.5	95.6	96.6	96.6	97.0	98.0	97.3	95.6	90.3	93.8	93.1	92.5	92.6	92.5	90.8	90.1	89.5	88.3	89.8	89.8
2 000	91.0	94.5	95.4	96.0	96.0	97.4	96.9	94.9	88.2	92.4	91.9	90.7	91.7	91.2	89.7	87.9	87.4	86.5	89.0	88.7
2 500	88.9	92.6	94.1	94.9	95.1	96.6	96.3	95.9	86.9	90.3	90.9	89.8	89.6	89.4	89.4	86.4	84.9	86.6	86.3	86.3
3 150	89.7	93.1	94.6	95.7	96.9	96.6	96.6	97.1	87.6	91.2	91.7	90.9	89.9	89.2	87.2	86.7	86.2	86.9	86.7	87.4
4 000	90.2	93.2	94.2	95.1	95.4	97.1	96.6	94.6	86.7	91.4	89.6	88.7	88.7	87.7	85.4	85.6	85.1	84.7	86.6	86.6
5 000	88.4	91.4	91.7	93.1	93.1	96.9	94.7	93.9	84.2	88.4	86.4	85.6	85.7	84.7	85.1	83.2	82.2	83.1	84.9	83.2
6 300	84.8	87.8	90.0	92.0	93.1	94.8	93.5	93.8	84.8	86.0	87.0	85.5	83.6	84.8	83.6	83.0	82.0	82.6	82.1	82.1
8 000	84.3	87.4	89.6	91.6	92.3	94.6	93.4	92.9	83.9	86.4	84.8	83.3	83.9	83.1	82.3	80.8	80.6	82.1	82.9	81.6
10 000	82.1	85.8	87.8	90.3	91.8	93.8	93.0	92.6	82.6	83.8	83.8	82.8	81.6	81.8	81.1	80.5	80.3	81.5	81.1	80.1
12 500	80.6	83.6	85.6	88.2	89.4	92.7	91.2	91.6	80.9	82.1	82.1	80.4	78.4	79.4	79.2	77.7	78.1	79.1	78.6	78.1
16 000	76.4	79.9	83.0	85.7	86.9	89.9	88.7	89.0	78.4	79.4	79.7	77.9	77.0	76.4	77.0	74.9	75.4	76.7	76.4	74.5
20 000	73.1	75.9	79.4	82.3	83.3	86.6	85.6	86.3	74.8	76.3	77.1	75.1	73.6	73.3	74.4	71.9	71.8	73.3	72.4	71.4
Overall	109.1	111.1	111.7	111.7	112.0	111.6	110.1	109.3	106.6	109.6	109.8	109.4	109.2	108.4	107.2	105.9	104.9	104.9	105.5	106.5

TABLE I. - Continued. ONE-THIRD-OCTAVE-BAND SOUND PRESSURE LEVEL ON 15.24-METER-RADIUS CIRCLE

FOR EXTERNALLY BLOWN FLAP WITH SEVEN-LOBE MIXER NOZZLE

[Sound pressure level referenced to 2×10^{-5} N/m^2. Data corrected for atmospheric attenuation (lossless).]

(c) Run 3. Flap setting, 30°-60°; nozzle pressure ratio, 1.4; nozzle exhaust velocity, 235 m/sec; nozzle temperature, 300 K; ambient temperature, 294 K; relative humidity, 40 percent; barometric pressure, 101.3×10^3 N/m^2.

Frequency, Hz	Angle, deg																			
	10	25	40	55	70	85	100	105	155	170	185	200	215	230	250	270	290	310	330	350
	Sound pressure level, dB																			
50	89.2	89.7	91.7	91.5	90.7	90.3	88.3	88.2	84.5	87.3	88.0	89.5	90.0	90.3	90.0	88.3	86.2	83.8	84.7	85.3
63	90.2	90.2	91.7	92.5	91.8	90.8	88.7	86.8	85.2	87.7	88.8	88.8	90.3	90.2	90.2	89.3	87.7	86.0	84.5	87.2
80	91.0	90.7	92.7	91.8	91.0	89.0	88.0	86.3	86.2	87.8	87.2	88.3	88.0	88.0	88.3	89.0	87.7	85.5	85.0	86.8
100	90.7	91.2	91.7	90.5	89.2	88.4	85.5	85.8	87.7	89.2	90.9	90.9	90.5	90.4	90.4	88.0	89.0	86.7	86.4	87.9
125	94.2	94.7	96.0	94.2	93.0	90.9	89.0	89.0	91.0	93.9	95.9	96.4	96.5	94.4	93.5	92.0	91.4	91.0	90.7	91.7
160	96.4	98.7	98.9	97.2	95.7	95.2	93.0	93.7	95.0	97.5	99.0	100.0	99.5	98.9	97.7	93.5	93.0	93.0	92.7	94.5
200	98.9	100.4	99.7	98.5	99.7	97.2	95.5	95.2	95.9	98.7	100.0	100.4	99.7	98.4	96.7	95.2	92.9	94.2	95.0	95.9
250	98.2	99.4	99.0	99.9	100.5	98.4	95.7	94.5	93.5	96.9	98.4	97.4	95.2	95.2	94.0	94.4	92.5	93.9	95.0	96.2
315	95.6	96.7	96.9	96.4	97.6	96.4	94.4	94.4	93.6	95.7	95.6	94.9	94.2	92.4	91.9	90.2	90.6	91.7	92.7	92.7
400	94.6	97.1	98.1	97.4	98.7	98.6	96.6	95.4	93.7	96.1	96.4	95.6	95.1	94.1	92.4	92.2	91.7	91.1	90.4	92.2
500	94.4	96.4	97.6	97.4	98.6	98.1	95.4	94.4	90.9	94.1	93.6	91.9	91.9	92.1	91.3	90.3	89.4	89.1	88.3	91.6
630	93.3	95.3	96.3	97.1	97.4	96.6	94.6	94.1	90.3	93.4	92.6	91.6	91.8	90.9	90.9	89.4	88.8	88.3	88.3	89.6
800	93.3	95.0	96.3	96.8	97.0	95.3	94.6	94.1	89.8	93.5	92.1	91.5	91.1	90.8	90.8	89.8	89.6	88.1	88.8	88.1
1 000	92.5	95.0	95.7	96.2	95.8	95.0	94.5	93.8	89.2	92.0	91.8	91.0	90.7	90.7	90.3	90.0	89.3	88.0	89.0	87.7
1 250	91.4	93.7	94.4	94.7	95.4	94.7	94.2	93.4	88.4	91.4	91.2	90.2	90.2	90.7	89.4	89.4	88.6	87.2	87.7	88.4
1 600	90.0	92.6	93.3	93.5	94.0	94.1	93.5	92.1	87.3	90.5	89.3	89.3	89.5	89.3	87.6	87.0	86.6	85.0	86.5	86.8
2 000	88.4	91.4	91.9	92.4	92.4	93.5	93.2	91.9	85.4	89.0	87.9	87.2	87.9	87.5	86.4	84.7	84.4	83.5	86.2	85.7
2 500	85.9	88.9	91.1	91.6	91.8	92.3	92.1	92.8	83.5	86.9	86.9	86.6	86.1	85.8	85.9	83.1	82.1	83.3	83.1	83.3
3 150	86.6	89.7	91.2	92.4	93.7	92.7	92.7	92.9	84.6	87.9	88.1	87.1	86.6	86.1	84.2	83.6	83.1	83.7	83.1	83.7
4 000	87.1	90.1	90.6	91.7	92.2	93.2	92.7	91.1	82.0	87.6	85.9	85.1	85.4	84.2	81.7	82.1	81.9	81.6	83.4	83.2
5 000	85.7	87.9	88.6	90.1	89.9	92.9	91.2	90.4	80.6	84.9	82.6	81.9	82.1	81.6	81.2	79.4	79.1	80.2	81.2	79.6
6 300	81.5	84.3	86.3	88.5	89.8	91.3	89.8	90.3	81.3	82.3	83.3	81.3	79.6	81.3	79.6	79.3	79.0	80.1	78.8	78.6
8 000	80.8	84.3	86.3	87.9	88.8	90.9	90.3	89.9	80.4	82.8	80.6	79.3	79.9	79.4	78.4	77.3	77.9	79.4	79.8	78.8
10 000	78.6	82.5	84.8	87.1	88.1	90.5	89.5	89.0	79.5	80.1	80.1	79.1	78.0	78.0	77.1	77.0	78.0	79.1	78.5	77.3
12 500	77.2	80.1	82.1	84.9	86.6	89.6	87.9	87.3	77.7	78.2	78.4	76.4	74.9	75.1	75.6	74.4	75.7	76.7	76.1	74.6
16 000	72.7	76.5	79.7	82.2	84.2	86.9	85.5	86.1	75.0	75.9	75.9	74.0	73.0	72.7	73.0	71.4	73.0	74.5	73.7	71.7
20 000	69.8	72.9	76.4	79.1	80.3	83.1	82.4	82.5	71.8	72.6	73.4	71.1	69.6	69.6	70.6	68.6	69.4	70.9	69.8	68.3
Overall	106.6	108.3	108.9	108.8	109.2	108.5	107.0	106.4	103.8	106.6	107.2	107.1	106.6	105.8	104.8	103.4	102.5	102.4	102.8	103.8

TABLE I. - Continued. ONE-THIRD-OCTAVE-BAND SOUND PRESSURE LEVEL ON 15.24-METER-RADIUS CIRCLE FOR EXTERNALLY BLOWN FLAP WITH SEVEN-LOBE MIXER NOZZLE

[Sound pressure level referenced to 2×10^{-5} N/m^2. Data corrected for atmospheric attenuation (lossless).]

(d) Run 4. Flap setting, 30°-60°; nozzle pressure ratio, 1.3; nozzle exhaust velocity, 208 m/sec; nozzle temperature, 298 K; ambient temperature, 294 K; relative humidity, 40 percent; barometric pressure, 101.3×10^3 N/m^2.

Frequency, Hz	Angle, deg																			
	10	25	40	55	70	85	100	105	155	170	185	200	215	230	250	270	290	310	330	350
	Sound pressure level, dB																			
50	86.7	88.2	89.5	90.0	89.7	88.5	86.5	85.5	82.0	85.0	85.8	87.3	88.2	88.5	88.7	86.7	84.8	82.3	82.3	83.7
63	87.0	88.8	89.8	90.0	90.3	88.8	86.5	85.8	82.7	84.7	85.3	86.8	87.8	87.8	88.2	88.0	86.2	84.2	83.3	85.2
80	88.0	89.3	91.2	89.8	89.9	88.3	85.7	84.8	83.8	84.2	85.2	86.0	85.7	86.3	87.2	87.2	86.5	84.5	82.8	85.2
100	87.5	88.2	90.4	88.0	88.0	86.4	83.9	82.9	85.0	86.7	87.7	88.2	88.0	87.4	87.7	86.9	86.7	84.4	84.2	85.5
125	91.7	91.7	93.2	91.4	90.4	89.2	87.5	87.2	88.7	91.2	92.5	93.9	93.9	92.9	90.5	89.9	88.5	88.2	88.0	88.9
160	94.4	95.7	96.5	94.0	93.0	92.4	90.2	89.5	92.0	94.4	96.0	96.9	96.5	95.9	94.4	90.7	89.7	90.2	90.0	91.4
200	95.2	96.9	96.5	95.7	96.2	94.2	92.9	92.4	92.4	95.0	95.9	96.2	96.4	94.9	93.7	92.4	90.2	91.2	92.0	92.0
250	94.7	96.5	95.7	95.7	96.2	95.2	92.9	91.5	90.4	93.5	93.7	93.4	91.9	92.2	90.5	91.4	89.0	90.4	91.5	92.5
315	91.9	92.9	93.4	92.9	93.9	92.9	91.2	90.1	89.9	91.1	91.1	91.1	90.6	89.4	88.1	86.6	86.4	87.9	88.7	88.9
400	90.1	93.4	94.1	93.7	94.7	94.6	93.6	91.9	89.9	92.2	92.1	91.2	91.1	90.6	88.7	88.7	88.2	87.2	86.7	88.4
500	90.3	92.6	93.3	93.8	94.4	93.9	91.9	90.4	87.1	90.1	88.6	87.9	88.3	88.4	86.9	86.4	85.8	85.6	84.6	87.4
630	89.6	91.4	92.1	92.9	93.3	92.9	91.3	89.9	86.1	89.1	88.3	87.1	87.9	86.9	86.8	85.9	85.3	84.1	83.9	85.8
800	89.5	91.0	92.3	92.5	92.5	91.6	91.0	89.8	85.8	88.6	87.6	87.1	86.6	86.8	86.8	86.0	85.8	84.1	85.0	84.1
1 000	87.8	90.8	91.2	91.8	91.7	91.7	90.3	90.2	84.7	87.3	87.3	86.2	86.7	86.8	86.5	86.3	85.5	83.8	84.7	83.5
1 250	87.2	89.2	89.9	90.9	91.6	90.9	90.1	89.7	84.2	86.9	86.2	85.9	86.1	86.7	85.2	85.1	84.9	83.1	83.9	84.4
1 600	85.3	88.0	89.0	89.3	90.0	90.5	89.8	88.1	82.8	85.6	84.5	84.6	84.5	85.1	83.3	83.0	82.3	81.1	82.6	82.6
2 000	83.9	86.9	87.7	88.4	88.2	90.0	89.2	87.0	80.7	84.2	82.7	82.4	83.5	83.2	82.2	80.9	80.7	79.5	81.9	81.0
2 500	81.4	84.6	86.8	87.3	87.6	88.9	87.9	87.9	78.9	82.3	81.6	81.4	81.4	81.4	81.4	79.3	78.1	79.4	79.1	78.8
3 150	82.1	85.2	87.1	88.1	89.6	89.1	88.6	89.2	80.1	83.1	82.9	82.4	81.7	81.7	79.9	79.9	79.2	80.2	79.6	79.6
4 000	82.6	85.4	86.4	87.4	87.9	89.7	88.7	86.9	78.9	82.7	80.6	80.2	80.9	79.7	77.4	77.9	77.9	77.7	79.1	78.7
5 000	80.6	83.6	84.2	85.6	85.9	89.2	87.2	86.4	76.2	79.9	77.2	76.9	77.1	76.6	76.6	75.2	75.2	75.9	77.2	75.6
6 300	76.6	79.8	62.1	84.3	86.0	87.3	86.0	86.5	77.0	77.6	77.8	76.3	74.8	76.5	75.3	74.8	75.3	76.0	74.6	74.5
8 000	76.4	79.4	82.1	84.3	85.6	87.9	86.8	86.8	76.6	78.1	75.8	74.4	75.4	75.1	73.8	73.1	74.4	75.8	75.4	74.3
10 000	74.6	78.1	80.8	83.5	85.0	87.3	86.3	86.3	76.0	76.1	75.3	74.6	73.5	73.3	72.8	73.0	75.0	75.5	75.0	72.8
12 500	73.1	75.6	78.4	81.1	82.7	86.4	84.6	85.2	74.1	74.2	73.7	71.6	70.4	70.7	70.9	69.9	72.4	73.6	71.9	70.7
16 000	68.5	72.2	75.9	78.4	80.2	83.2	82.0	82.5	71.5	71.7	71.2	69.2	68.7	68.0	68.4	67.2	69.5	70.5	69.4	67.4
20 000	65.6	68.6	72.4	75.3	76.8	79.8	78.8	79.3	68.1	68.4	68.4	66.1	65.4	65.1	65.6	64.3	66.1	67.1	65.6	64.3
Overall	103.1	104.9	105.5	105.1	105.5	105.1	103.6	102.8	100.3	102.8	103.1	103.4	103.3	102.7	101.5	100.5	99.4	99.2	99.5	100.3

TABLE I. - Continued. ONE-THIRD-OCTAVE-BAND SOUND PRESSURE LEVEL ON 15.24-METER-RADIUS CIRCLE FOR EXTERNALLY BLOWN FLAP WITH SEVEN-LOBE MIXER NOZZLE

[Sound pressure level referenced to 2×10^{-5} N/m^2. Data corrected for atmospheric attenuation (lossless).]

(e) Run 5. Flap setting, 30°-60°; nozzle pressure ratio, 1.2; nozzle exhaust velocity, 173 m/sec; nozzle temperature, 298 K; ambient temperature, 294 K; relative humidity, 40 percent; barometric pressure, 101.3×10^3 N/m^2.

Frequency, Hz	Angle, deg																			
	10	25	40	55	70	85	100	105	155	170	185	200	215	230	250	270	290	310	330	350
	Sound pressure level, dB																			
50	84.2	85.2	85.8	86.5	86.2	85.8	83.8	83.5	79.7	81.2	82.5	83.7	84.3	84.8	85.5	84.3	82.0	79.8	79.2	79.8
63	84.3	86.5	87.3	87.8	88.0	86.7	84.5	83.5	80.2	81.5	82.7	83.0	83.8	85.3	85.7	84.3	83.8	81.5	80.2	81.0
80	85.3	85.5	88.2	87.2	87.5	86.0	83.7	82.5	80.7	81.3	81.8	82.7	83.3	84.3	85.2	84.5	84.3	82.5	81.8	82.5
100	83.9	84.2	85.7	84.7	84.4	82.4	80.2	79.7	80.5	82.4	83.4	83.7	83.9	82.7	83.5	82.7	82.5	81.5	80.5	81.0
125	86.9	87.7	88.9	86.7	86.2	84.9	83.0	83.2	84.2	86.2	87.9	89.2	89.5	87.7	86.5	85.4	84.0	84.9	84.0	85.0
160	89.0	90.9	91.4	89.7	88.4	87.4	85.4	85.4	87.2	89.5	90.7	91.4	91.2	90.9	89.4	86.2	85.9	85.2	84.7	85.2
200	90.4	92.2	91.7	90.2	90.5	89.0	87.5	87.5	87.7	89.5	90.0	91.0	90.9	89.9	89.7	87.4	85.5	86.9	86.9	86.9
250	89.2	91.7	90.4	90.9	91.2	89.5	87.9	87.0	85.7	87.7	88.9	88.0	86.5	87.7	85.4	85.7	83.7	85.0	85.9	86.7
315	86.1	87.4	88.2	87.2	88.2	87.6	85.9	85.2	84.4	85.6	85.7	85.2	84.7	82.7	83.1	81.7	81.2	83.4	83.6	83.2
400	84.4	87.4	88.7	87.7	88.9	88.6	86.9	86.4	84.4	85.9	85.9	85.2	85.4	84.4	83.6	83.2	82.6	81.7	81.6	82.4
500	84.8	86.4	87.4	87.8	88.3	87.4	85.6	85.1	81.4	83.4	82.8	81.6	82.4	82.8	81.6	81.1	80.3	81.1	79.3	82.3
630	84.1	85.6	86.1	86.8	87.3	86.1	84.8	84.4	80.9	82.6	81.8	81.3	81.8	80.9	81.1	80.6	79.4	78.9	78.3	80.4
800	83.3	85.1	86.3	86.3	86.1	85.3	84.5	84.1	80.3	82.1	81.1	80.8	80.6	80.6	81.1	80.1	79.8	78.8	78.6	79.1
1 000	81.8	83.5	84.8	85.3	85.2	85.2	84.2	84.0	79.5	80.8	80.7	80.0	80.5	80.8	80.5	80.8	79.2	78.3	78.7	78.0
1 250	81.6	84.1	83.9	84.1	85.1	84.6	83.7	83.7	78.6	80.7	79.7	79.9	79.7	80.6	79.7	80.2	79.6	77.9	78.9	80.9
1 600	80.0	82.0	82.3	83.1	82.8	83.5	82.8	82.1	76.8	79.3	77.8	78.3	78.5	78.8	77.5	77.6	77.3	76.1	77.5	79.6
2 000	79.0	81.0	81.7	82.0	81.4	83.2	82.4	80.9	74.7	77.5	76.0	76.0	76.9	77.0	76.5	75.7	76.4	74.5	78.2	77.9
2 500	75.8	78.1	80.4	80.6	80.9	81.9	81.6	82.1	73.1	75.8	75.1	74.9	75.1	75.3	76.1	73.8	73.1	73.9	73.6	73.9
3 150	76.1	79.1	80.4	81.4	82.4	82.1	82.2	83.4	73.7	76.7	76.2	75.9	75.4	75.4	74.1	74.6	74.1	75.1	73.7	74.2
4 000	76.4	78.7	79.7	80.9	81.1	82.7	82.2	81.4	73.1	76.2	73.6	73.7	74.2	73.6	71.1	72.4	72.2	72.2	73.6	73.4
5 000	74.4	76.9	77.4	78.6	78.9	82.9	81.4	80.9	70.4	73.6	70.2	70.1	70.4	70.1	70.2	68.9	69.4	70.7	71.4	69.7
6 300	70.5	73.1	75.3	78.0	79.0	81.5	81.0	82.0	71.5	71.5	70.8	69.1	68.0	69.6	68.8	68.8	69.8	70.8	69.5	69.6
8 000	70.4	73.6	76.1	77.9	78.9	82.9	82.8	83.4	71.8	72.6	69.8	67.9	68.8	68.9	67.8	67.4	69.6	70.9	70.8	68.9
10 000	68.3	72.1	74.8	77.1	78.5	82.1	81.6	82.3	70.5	70.3	69.1	68.3	67.1	67.1	66.6	67.1	69.5	70.3	69.5	67.6
12 500	66.4	69.7	71.9	75.1	76.4	80.7	79.4	80.4	68.2	68.2	67.1	65.1	63.9	64.2	64.4	64.2	66.7	67.2	66.1	64.9
16 000	61.9	65.9	69.4	72.0	73.4	77.7	76.7	77.7	65.2	65.2	64.4	62.7	62.0	61.7	61.9	61.4	63.9	64.5	63.5	61.2
20 000	59.1	62.3	65.6	68.8	69.9	73.8	73.1	74.1	62.1	62.1	62.1	59.4	58.8	58.3	59.6	58.4	60.1	60.8	59.6	58.4
Overall	98.1	99.9	100.3	99.9	100.1	99.5	98.1	97.9	95.4	97.2	97.8	98.1	98.1	97.7	97.1	95.8	94.9	94.7	94.6	95.2

TABLE I. - Continued. ONE-THIRD-OCTAVE-BAND SOUND PRESSURE LEVEL ON 15.24-METER-RADIUS CIRCLE

FOR EXTERNALLY BLOWN FLAP WITH SEVEN-LOBE MIXER NOZZLE

[Sound pressure level referenced to 2×10^{-5} N/m^2. Data corrected for atmospheric attenuation (lossless).]

(f) Run 6. Flap setting, 10°-20°; nozzle pressure ratio, 1.7; nozzle exhaust velocity, 282 m/sec; nozzle temperature, 281 K; ambient temperature, 284 K; relative humidity, 36 percent; barometric pressure, 98.6×10^3 N/m^2.

Frequency, Hz	Angle, deg																			
	10	25	40	55	70	85	100	115	125	135	145	195	205	215	230	250	270	290	315	340
	Sound pressure level, dB																			
50	87.3	89.7	91.2	92.3	93.3	94.0	93.0	92.3	90.7	89.0	88.3	89.7	90.8	91.5	92.3	92.7	92.8	91.3	87.3	82.8
63	89.2	90.8	91.7	93.2	94.3	93.8	92.0	90.3	89.7	88.2	87.5	88.5	89.2	90.7	91.3	92.8	93.2	92.0	88.2	84.2
80	88.7	90.4	92.7	92.9	93.4	92.2	90.7	88.7	87.4	87.2	87.0	87.7	88.0	89.0	89.5	90.9	91.4	90.4	87.7	85.5
100	88.7	91.4	91.0	91.0	89.7	88.9	87.2	87.5	87.5	88.2	88.5	89.7	90.4	90.5	90.7	89.7	90.0	90.9	87.2	85.4
125	92.2	93.7	92.7	93.0	92.9	93.2	93.0	93.2	93.5	92.9	94.9	95.5	95.9	95.5	96.9	96.4	94.9	94.0	93.0	90.5
160	95.2	97.7	98.5	98.2	97.7	98.4	98.9	98.4	98.9	99.5	99.9	101.4	101.0	100.2	101.5	101.0	99.5	97.4	96.7	96.4
200	99.4	101.5	101.9	100.7	101.0	101.4	101.4	101.4	101.0	101.5	101.9	103.7	103.2	102.2	103.4	102.2	101.7	100.2	97.9	98.5
250	100.7	102.2	101.6	101.9	102.7	102.1	101.6	101.2	100.4	101.2	100.6	101.6	100.6	100.6	101.1	100.6	98.4	100.1	96.2	98.6
315	99.1	99.2	99.7	99.7	99.4	99.2	99.2	99.1	99.6	99.7	100.9	101.9	100.6	99.7	101.1	98.1	96.6	96.9	95.1	94.6
400	99.3	100.1	100.9	101.3	102.1	102.4	103.1	103.8	103.8	103.8	103.9	103.9	102.3	101.9	101.6	100.4	99.8	99.3	98.1	95.9
500	99.1	99.3	100.1	100.6	102.1	102.3	101.5	101.0	101.6	101.5	101.6	99.8	99.6	98.5	98.0	97.3	96.5	95.8	95.5	94.8
630	96.3	98.5	99.5	99.8	101.3	102.3	101.5	102.0	101.7	102.2	102.3	98.8	99.7	98.3	97.8	97.7	96.7	95.8	94.7	94.7
800	95.4	99.0	99.0	100.5	101.5	101.4	100.7	101.2	102.2	102.7	102.2	98.4	100.0	98.4	97.5	97.4	96.5	96.2	94.9	93.9
1 000	94.1	98.1	98.6	99.9	100.4	100.6	100.7	101.2	102.6	103.1	101.7	97.6	98.9	96.9	96.7	96.4	95.2	95.7	93.2	93.1
1 250	93.5	97.8	98.0	99.0	99.6	100.5	100.8	101.3	102.5	103.0	101.5	96.5	99.0	96.8	96.1	95.8	94.6	94.1	92.6	92.6
1 600	92.7	96.4	97.1	97.6	98.6	99.6	99.9	100.2	102.1	101.9	100.2	94.1	98.1	95.4	93.7	93.1	92.6	91.7	90.9	91.9
2 000	92.0	95.5	96.5	97.0	97.0	99.2	99.5	99.0	101.0	100.5	98.5	92.7	96.8	94.2	93.5	91.8	90.3	89 7	89.2	90.8
2 500	90.3	94.1	95.6	96.6	96.4	98.6	98.8	100.1	99.8	99.8	98.4	92.3	96.3	93.1	93.9	91.1	88.6	88.3	87.9	89.4
3 150	90.8	95.9	96.1	97.6	98.4	99.3	99.8	101.6	101.6	101.9	99.9	92.8	96.6	94.1	92.1	91.3	89.9	90.1	90.1	90.9
4 000	90.6	95.6	96.0	97.1	97.8	99.6	99.3	99.3	101.6	100.3	97.5	90.5	95.0	92.5	90.1	89.3	89.1	88.5	89.0	89.6
5 000	89.7	93.5	93.9	95.2	95.4	98.4	97.0	98.0	99.5	97.2	94.2	87.9	92.4	89.9	89.2	87.5	86.5	86.0	86.0	87.2
6 300	85.7	90.0	91.7	94.0	95.0	96.7	96.7	98.2	97.5	98.0	95.4	87.7	90.7	90.2	88.5	87.5	85.7	84.5	86.2	86.4
8 000	85.4	90.4	90.9	93.3	95.1	96.4	95.9	96.8	98.3	95.3	92.8	85.4	89.1	87.8	87.1	85.9	84.1	83.3	84.6	85.4
10 000	83.4	87.4	89.4	92.4	93.3	95.9	95.1	95.9	95.8	95.3	92.3	85.1	87.9	87.1	86.4	84.8	83.8	82.8	83.9	83.6
12 500	81.4	85.0	87.4	89.7	91.5	94.0	93.2	94.4	94.2	92.4	90.4	82.7	84.7	84.4	84.9	82.7	80.7	79.5	80.9	81.2
16 000	77.2	81.7	84.4	87.4	89.0	91.4	90.5	91.9	91.7	90.2	88.4	80.7	82.5	81.9	82.7	80.0	78.0	77.4	78.5	78.4
20 000	74.5	78.5	81.2	84.0	86.0	88.2	87.8	89.7	88.5	87.7	86.3	78.0	80.0	79.2	80.8	77.5	75.5	74.7	75.8	75.3
Overall	108.7	110.9	111.3	111.9	112.6	113.2	113.0	113.4	113.9	113.9	113.2	111.6	111.8	110.7	111.0	110.1	109.1	108.5	106.9	106.8

TABLE I. - Continued. ONE-THIRD-OCTAVE-BAND SOUND PRESSURE LEVEL ON 15.24-METER-RADIUS CIRCLE FOR EXTERNALLY BLOWN FLAP WITH SEVEN-LOBE MIXER NOZZLE

[Sound pressure level referenced to 2×10^{-5} N/m^2. Data corrected for atmospheric attenuation (lossless).]

(g) Run 7. Flap setting, 10^{o}-20^{o}; nozzle pressure ratio, 1.5; nozzle exhaust velocity, 252 m/sec; nozzle temperature, 289 K; ambient temperature, 284 K; relative humidity, 36 percent; barometric pressure, 98.6×10^{3} N/m^2.

Frequency, Hz	Angle, deg																			
	10	25	40	55	70	85	100	115	125	135	145	195	205	215	230	250	270	290	315	340
	Sound pressure level, dB																			
50	85.0	88.3	90.0	90.0	91.8	92.3	90.8	90.0	88.0	87.3	86.2	86.2	88.2	88.8	90.3	90.8	91.3	89.7	84.8	80.8
63	86.0	88.0	89.7	90.8	91.5	91.8	89.8	89.5	87.7	85.8	85.0	85.8	86.8	87.3	89.3	90.7	90.3	89.5	86.2	81.7
80	86.5	88.5	89.9	91.0	91.0	90.0	88.0	86.4	84.9	84.5	83.9	85.0	85.2	86.2	86.9	88.4	89.2	88.7	85.2	82.0
100	86.0	88.7	88.4	88.5	88.0	86.9	85.2	84.9	84.7	85.4	85.7	86.0	87.9	86.7	87.9	87.7	88.2	87.9	85.4	83.4
125	90.4	90.9	90.5	90.5	90.5	90.9	90.9	90.7	90.9	90.2	91.5	93.2	93.0	93.0	95.0	93.9	92.4	92.2	90.9	88.9
160	92.4	94.9	96.2	96.2	95.0	95.7	96.2	95.9	96.7	95.7	97.0	98.2	98.2	98.0	98.9	99.0	97.5	95.0	94.9	94.2
200	95.4	98.0	98.9	98.5	98.7	98.5	98.5	98.7	98.2	98.7	98.4	99.9	99.7	99.7	100.4	100.0	98.9	96.5	96.0	95.2
250	97.6	99.4	98.2	98.7	100.2	99.2	98.7	97.9	97.9	97.9	96.7	97.6	97.2	97.7	98.1	97.7	95.6	96.6	93.6	96.4
315	94.6	95.1	95.9	95.4	95.4	95.4	95.2	95.2	95.9	95.7	96.7	96.9	95.9	95.4	95.9	93.9	93.2	93.2	91.2	91.4
400	94.9	96.3	96.9	97.4	98.1	98.6	99.4	99.6	100.1	99.8	99.6	98.6	97.3	97.1	96.9	96.6	95.4	94.4	93.6	91.4
500	95.5	96.0	96.0	96.5	98.1	98.3	97.5	97.1	97.5	97.0	97.0	95.1	95.0	94.0	93.1	92.6	91.8	91.8	91.5	90.5
630	92.5	94.2	94.8	95.3	97.0	98.0	97.5	97.8	97.8	97.7	97.7	94.3	94.8	94.2	93.0	93.2	92.3	91.3	90.0	89.8
800	91.4	94.0	95.0	96.0	96.9	97.2	96.5	96.9	97.7	98.2	97.7	93.7	95.0	93.2	92.7	92.9	91.7	91.5	90.7	90.2
1 000	89.9	93.4	94.6	95.9	96.2	96.2	96.6	96.9	98.1	98.7	97.4	92.4	94.2	92.4	92.2	92.1	90.9	91.2	89.9	89.7
1 250	89.8	93.8	93.6	94.5	95.5	96.3	96.6	96.6	98.1	98.1	97.0	91.6	94.1	92.0	91.3	91.6	90.3	90.0	88.6	88.6
1 600	88.6	92.4	92.2	93.4	94.2	95.4	95.7	95.7	97.7	97.4	95.9	89.7	92.9	90.6	88.9	88.9	87.9	87.7	86.7	87.9
2 000	87.2	91.2	91.8	92.5	93.2	95.0	95.5	94.8	96.8	95.8	93.8	88.0	91.8	89.2	88.7	87.0	85.8	85.7	85.7	87.0
2 500	85.6	89.6	90.8	92.1	92.1	94.4	94.8	95.8	95.4	95.1	93.9	87.3	90.9	88.6	88.9	86.4	84.4	84.4	83.9	85.3
3 150	85.8	91.1	91.4	93.3	93.9	95.1	95.3	97.3	97.4	97.1	95.1	88.3	91.6	88.9	87.3	86.8	85.6	85.9	85.9	86.6
4 000	86.3	91.1	91.1	92.5	93.3	95.5	95.0	95.0	97.1	95.8	92.8	86.3	90.5	87.6	85.6	84.8	84.5	84.5	85.3	85.6
5 000	85.2	88.7	89.0	90.9	91.0	94.0	92.9	93.2	95.2	92.5	89.9	83.7	87.9	84.9	84.4	82.7	81.5	81.9	82.5	83.2
6 300	81.0	85.9	86.9	89.7	90.5	92.5	92.7	93.5	92.7	93.4	90.5	83.7	85.9	84.9	83.2	82.9	80.9	80.9	82.9	82.9
8 000	81.1	86.1	86.8	88.9	90.6	92.4	91.8	92.6	93.8	90.9	87.8	81.4	84.1	83.1	82.3	80.9	79.3	79.6	81.3	81.8
10 000	79.3	83.4	84.9	88.4	89.1	92.3	91.1	91.8	91.9	90.6	87.4	80.6	83.1	81.8	81.1	79.9	78.9	79.8	81.6	80.9
12 500	77.5	80.9	82.7	85.9	87.7	90.4	89.4	90.2	89.5	88.0	86.0	78.2	80.4	79.5	79.4	77.7	76.4	76.7	78.7	78.4
16 000	73.7	77.7	80.0	83.4	85.0	88.0	86.9	88.0	87.7	85.2	83.7	76.0	77.7	77.0	77.5	75.4	73.4	74.5	76.9	75.7
20 000	71.0	74.7	77.2	80.3	82.0	84.5	84.7	85.5	84.3	82.7	81.3	73.7	75.3	74.3	76.2	72.8	71.2	71.7	73.8	73.0
Overall	105.0	107.1	107.6	108.2	108.9	109.5	109.3	109.4	110.0	109.7	108.9	107.3	107.6	107.0	107.3	106.9	105.8	104.9	103.7	103.5

TABLE I. - Continued. ONE-THIRD-OCTAVE-BAND SOUND PRESSURE LEVEL ON 15.24-METER-RADIUS CIRCLE FOR EXTERNALLY BLOWN FLAP WITH SEVEN-LOBE MIXER NOZZLE

[Sound pressure level referenced to 2×10^{-5} N/m^2. Data corrected for atmospheric attenuation (lossless).]

(h) Run 8. Flap setting, 10^{o}-20^{o}; nozzle pressure ratio, 1.4; nozzle exhaust velocity, 233 m/sec; nozzle temperature, 293 K; ambient temperature, 284 K; relative humidity, 36 percent; barometric pressure, 98.6×10^{3} N/m^2.

Frequency, Hz	Angle, deg																			
	10	25	40	55	70	85	100	115	125	135	145	195	205	215	230	250	270	290	315	240
	Sound pressure level, dB																			
50	82.8	87.0	88.2	89.5	90.5	90.2	89.3	87.8	86.3	86.0	84.3	84.2	86.7	87.5	89.3	89.8	89.0	87.5	83.3	79.8
63	84.8	86.7	87.5	89.3	90.3	90.0	88.3	86.8	86.0	84.8	82.5	84.7	85.0	86.2	88.3	89.2	89.5	88.0	84.5	80.3
80	84.9	86.7	88.5	88.7	89.4	88.2	86.4	85.5	83.9	83.5	82.9	84.2	84.0	84.4	86.2	87.0	87.9	87.9	84.4	81.4
100	84.4	87.0	86.9	87.0	86.2	85.0	83.7	83.2	83.5	83.4	83.7	84.7	85.7	85.5	86.7	86.2	86.5	87.4	84.5	81.7
125	88.7	89.4	88.4	89.2	88.7	89.0	88.9	89.7	89.9	89.5	90.0	90.9	91.5	92.4	93.4	92.2	91.0	90.7	89.5	88.0
160	90.5	93.4	93.5	94.4	93.5	94.4	94.4	94.0	94.7	94.9	95.0	95.7	96.0	96.5	97.4	97.0	95.2	93.7	92.7	92.4
200	93.2	96.2	96.5	96.5	96.9	96.7	97.0	96.9	96.4	96.9	96.5	96.9	97.0	97.9	99.0	97.9	97.2	94.7	93.9	94.0
250	95.4	97.7	96.6	96.1	97.2	97.4	96.6	96.1	95.6	95.6	94.6	94.4	94.4	95.4	95.4	94.9	94.1	94.9	92.1	94.7
315	92.1	92.7	93.2	92.7	92.7	93.1	92.7	93.1	93.4	93.1	94.2	93.7	93.1	92.7	93.4	91.4	89.9	90.6	88.4	88.9
400	92.6	94.1	94.3	95.1	96.3	95.9	96.9	97.8	97.8	97.3	96.6	95.3	94.4	94.3	94.4	93.6	92.4	91.9	90.6	88.9
500	92.5	93.1	93.5	94.1	95.8	95.3	94.6	94.6	94.8	94.1	94.1	91.8	92.0	91.0	90.8	90.0	89.3	89.5	89.1	88.0
630	89.8	91.3	92.2	93.5	94.3	95.3	94.7	95.0	94.8	95.0	94.8	91.2	91.3	90.7	89.7	90.0	89.3	88.8	87.5	87.5
800	89.0	91.0	92.4	93.9	94.0	94.5	93.7	94.0	94.9	95.7	94.7	90.5	91.5	90.0	89.7	89.5	88.9	88.9	87.4	86.4
1 000	86.7	90.9	91.9	92.7	93.7	93.6	93.6	94.1	95.1	95.7	94.4	89.2	91.1	89.1	89.6	88.9	87.6	88.7	86.7	86.1
1 250	87.1	91.0	91.1	92.1	92.6	92.6	93.5	93.6	93.8	95.1	94.3	88.3	90.6	88.8	88.0	88.3	87.6	87.1	86.0	86.5
1 600	85.7	89.7	89.9	90.7	91.7	92.6	92.9	92.9	94.7	94.2	93.2	86.4	89.6	86.9	85.9	85.9	84.9	85.1	84.2	85.6
2 000	84.3	88.2	89.3	89.8	90.7	92.2	92.3	92.2	94.0	92.8	91.2	84.7	88.3	85.7	85.5	84.0	82.7	83.0	83.7	84.8
2 500	82.1	86.8	88.6	89.6	89.4	91.6	91.9	92.6	92.3	92.3	90.9	83.9	87.4	84.8	85.9	83.4	81.3	81.4	81.3	82.9
3 150	82.4	88.3	88.6	90.8	91.4	92.3	92.6	94.1	94.1	93.8	92.1	85.1	88.1	85.6	83.9	84.1	82.6	83.1	83.4	83.9
4 000	83.0	88.0	88.5	90.0	91.3	92.6	92.3	92.1	94.3	92.8	89.8	83.1	86.5	83.8	82.0	81.3	81.3	81.6	82.8	83.0
5 000	81.9	85.9	86.7	87.9	88.4	91.5	90.4	90.9	92.0	89.7	86.7	80.0	84.0	81.2	80.9	79.5	78.2	79.0	80.0	80.9
6 300	77.9	82.5	84.4	87.4	87.9	90.2	90.0	91.0	90.2	90.4	87.5	80.4	82.5	81.0	79.7	79.2	77.9	78.2	80.5	80.2
8 000	78.3	82.9	84.1	86.6	88.6	90.4	89.8	89.9	91.4	87.9	84.9	77.8	80.9	79.1	78.4	77.6	76.3	77.1	79.3	79.4
10 000	76.3	80.3	82.9	85.9	87.3	90.3	88.8	89.4	89.1	87.8	84.8	77.4	79.6	78.6	77.9	76.6	76.1	77.8	79.4	78.3
12 500	74.7	78.4	80.4	83.5	85.9	88.7	87.2	87.9	87.4	84.5	83.4	75.2	76.5	76.0	76.4	74.4	73.7	74.7	77.0	76.2
16 000	70.9	75.0	77.9	80.9	83.4	85.9	84.9	85.7	85.2	82.7	80.5	72.9	74.4	73.4	74.2	72.0	70.7	72.7	74.7	73.4
20 000	68.2	72.0	75.0	78.2	80.2	82.3	82.0	82.8	81.8	80.0	78.2	70.5	71.7	71.2	72.5	69.5	68.2	69.7	72.0	70.2
Overall	102.6	104.9	105.2	105.9	106.6	107.1	106.8	107.1	107.4	107.1	106.3	104.3	104.8	104.7	105.2	104.5	103.6	102.9	101.5	101.5

TABLE I. - Continued. ONE-THIRD-OCTAVE-BAND SOUND PRESSURE LEVEL ON 15.24-METER-RADIUS CIRCLE

FOR EXTERNALLY BLOWN FLAP WITH SEVEN-LOBE MIXER NOZZLE

[Sound pressure level referenced to 2×10^{-5} N/m^2. Data corrected for atmospheric attenuation (lossless).]

(i) Run 9. Flap setting, 10°-20°; nozzle pressure ratio, 1.3; nozzle exhaust velocity, 206 m/sec; nozzle temperature, 293 K; ambient temperature, 284 K; relative humidity, 36 percent; barometric pressure, 98.6×10^3 N/m^2.

Frequency, Hz	Angle, deg																			
	10	25	40	55	70	85	100	115	125	135	145	195	205	215	230	250	270	290	315	340
	Sound pressure level, dB																			
50	81.8	83.8	86.0	86.8	88.2	88.2	87.3	86.2	85.0	83.5	81.7	82.0	83.7	85.3	86.5	87.5	87.3	86.0	82.0	77.5
63	82.0	84.7	85.3	87.3	88.0	87.7	87.2	85.7	83.5	83.3	81.0	81.5	82.8	84.3	85.3	87.0	87.2	86.0	83.3	79.0
80	82.2	84.7	86.4	87.4	88.4	86.5	85.7	83.9	82.2	81.4	80.2	80.9	81.2	82.7	83.7	85.9	86.5	86.0	83.0	80.0
100	82.5	85.2	84.2	84.7	84.5	83.7	81.8	80.8	82.2	81.2	81.4	82.0	83.0	83.0	84.0	84.7	85.0	85.2	83.5	80.4
125	87.2	87.5	85.7	87.2	86.5	86.5	88.4	87.8	88.5	87.5	88.0	89.2	90.4	90.4	91.4	90.4	89.9	89.4	88.2	86.0
160	87.5	91.0	92.2	92.0	91.5	91.7	92.7	93.2	92.9	92.7	92.7	92.7	93.9	94.0	95.2	95.2	93.2	91.7	91.2	89.7
200	90.5	93.7	93.7	93.9	94.0	94.0	94.4	94.0	94.2	93.7	93.5	93.4	94.4	95.0	96.2	95.2	93.5	92.0	91.7	91.2
250	92.7	95.1	94.1	92.4	93.7	93.6	93.2	92.7	93.1	92.7	91.9	91.1	91.2	91.7	92.2	91.4	91.1	92.4	89.6	91.4
315	88.1	89.7	89.6	89.2	89.4	89.4	89.9	89.9	90.1	90.1	90.6	89.4	89.1	89.4	89.7	87.7	86.9	87.2	85.2	85.4
400	88.8	90.8	91.4	91.6	92.9	92.6	93.6	94.4	94.1	93.8	92.9	91.1	90.3	90.3	90.8	90.1	88.9	88.4	87.3	85.8
500	88.5	89.5	90.0	90.6	91.8	91.5	90.8	90.8	91.1	90.6	90.3	87.8	88.0	86.6	86.1	86.0	85.6	85.6	85.1	84.1
630	85.7	87.7	88.5	89.7	90.8	91.5	90.5	91.0	91.0	90.8	90.7	87.0	87.2	85.8	85.7	86.3	85.3	84.8	83.5	83.2
800	85.2	87.7	88.9	89.7	90.0	90.4	90.4	90.0	90.9	91.2	90.5	86.5	87.2	85.2	85.4	85.5	84.9	84.7	83.4	82.5
1 000	82.9	87.2	88.1	89.1	89.4	89.7	90.1	89.7	91.2	91.6	90.4	85.4	86.4	84.4	84.9	84.6	83.9	84.4	82.9	82.6
1 250	83.1	86.6	87.0	88.0	88.5	89.5	89.8	89.6	90.8	91.1	90.5	84.3	85.8	83.8	83.8	84.3	83.3	83.3	82.1	83.0
1 600	82.1	85.6	85.9	86.6	87.6	88.6	88.7	88.7	90.7	90.4	88.9	81.9	84.6	82.4	81.4	81.6	81.2	80.9	80.6	81.6
2 000	80.7	83.8	84.8	86.2	86.3	88.2	88.3	87.7	89.5	88.7	87.0	80.3	83.2	81.2	81.2	80.2	79.2	79.3	79.7	80.8
2 500	78.6	82.3	84.3	85.4	85.3	87.6	87.4	88.3	88.4	87.9	86.6	79.9	82.3	80.1	81.8	79.4	77.6	77.9	78.1	78.9
3 150	79.1	84.1	84.6	86.4	87.1	88.4	88.3	89.8	90.1	89.9	87.6	81.1	83.3	80.6	79.8	79.6	78.4	79.3	80.3	80.1
4 000	79.0	83.8	84.1	85.6	86.6	88.6	87.8	87.6	90.1	88.5	85.3	79.1	81.8	79.1	77.3	77.3	77.3	77.8	79.3	79.1
5 000	77.9	81.2	82.0	83.5	84.0	87.4	86.0	86.2	88.0	85.4	82.2	76.4	79.2	76.5	76.2	75.4	74.4	75.2	76.0	76.5
6 300	74.2	78.4	80.0	82.7	83.9	86.4	86.0	86.9	85.9	86.0	83.0	76.0	77.5	76.2	75.4	75.2	73.5	74.5	76.7	76.0
8 000	74.1	78.9	79.9	82.3	84.3	86.4	85.9	86.3	87.3	83.9	80.9	74.1	76.4	74.8	74.8	73.3	72.4	73.9	75.9	75.4
10 000	72.4	76.6	78.9	82.1	82.8	86.3	85.4	85.6	85.1	83.6	80.1	73.6	75.6	73.6	73.6	72.4	72.4	74.6	75.6	74.4
12 500	70.7	74.0	76.4	79.2	81.5	84.5	83.4	83.7	83.2	80.9	79.0	71.2	72.0	71.5	72.0	70.4	69.4	71.4	72.9	72.0
16 000	66.5	70.7	74.2	76.5	79.0	82.0	80.9	81.4	80.9	78.5	76.7	69.0	70.2	69.0	69.5	67.9	66.5	69.2	71.0	69.2
20 000	64.5	67.8	70.5	74.0	76.0	78.3	77.8	78.8	77.7	75.8	74.3	66.3	67.3	66.3	68.0	65.0	64.2	66.2	67.8	66.2
Overall	99.3	101.9	102.1	102.5	103.2	103.6	103.6	103.6	104.0	103.6	102.8	100.7	101.5	101.4	102.1	101.7	100.7	100.2	98.9	98.3

TABLE I. - Continued. ONE-THIRD-OCTAVE-BAND SOUND PRESSURE LEVEL ON 15.24-METER-RADIUS CIRCLE

FOR EXTERNALLY BLOWN FLAP WITH SEVEN-LOBE MIXER NOZZLE

[Sound pressure level referenced to 2×10^{-5} N/m^2. Data corrected for atmospheric attenuation (lossless).]

(j) Run 10. Flap setting, 10^{o}-20^{o}; nozzle pressure ratio, 1.2; nozzle exhaust velocity, 173 m/sec; nozzle temperature, 293 K; ambient temperature, 284 K; relative humidity, 36 percent; barometric pressure, 98.6×10^{3} N/m^2.

Frequency, Hz	Angle, deg																			
	10	25	40	55	70	85	100	115	125	135	145	195	205	215	230	250	270	290	315	340
	Sound pressure level, dB																			
50	77.5	80.8	82.3	82.8	84.3	84.3	84.0	83.7	82.5	80.7	78.7	78.7	80.3	82.7	83.2	84.3	84.3	83.8	79.0	75.3
63	78.5	81.2	83.8	84.3	85.5	85.7	84.8	82.7	82.0	80.0	78.3	78.7	79.7	81.5	82.3	84.7	84.7	84.2	81.5	76.7
80	79.4	81.2	83.0	84.9	85.4	84.4	82.5	80.9	79.0	78.2	77.2	78.0	78.9	79.9	81.0	83.0	84.5	84.4	80.9	77.4
100	79.2	81.2	81.2	82.0	81.5	80.2	78.7	78.7	78.4	77.2	77.4	78.9	80.0	80.4	81.5	81.2	81.9	82.4	79.9	77.9
125	85.7	84.0	82.5	83.9	84.2	84.2	84.2	84.5	85.2	84.5	84.7	85.7	87.4	88.0	88.4	86.7	87.0	87.2	86.0	84.7
160	82.9	86.5	87.5	87.5	87.2	88.0	87.7	89.0	89.2	89.0	88.9	87.7	89.4	89.9	91.4	90.7	88.7	87.0	86.9	84.9
200	85.9	90.2	90.2	89.2	89.5	89.4	89.7	90.0	89.9	89.5	89.5	87.5	89.0	89.9	90.4	89.9	89.5	87.0	88.4	86.9
250	86.6	89.7	89.6	87.9	88.2	88.6	88.9	88.4	87.7	88.1	87.1	85.4	84.9	85.9	86.4	86.6	86.6	86.7	85.2	85.7
315	83.1	84.4	83.9	83.6	83.7	84.2	84.6	84.7	85.2	85.1	84.9	83.9	84.1	83.7	84.2	82.6	81.2	81.7	80.2	80.2
400	82.9	85.6	85.4	85.9	87.3	87.3	87.9	88.8	89.1	88.4	87.6	85.3	84.9	84.9	84.8	83.9	83.1	82.9	81.6	81.6
500	82.6	84.0	84.1	85.0	86.0	85.6	85.0	85.0	85.3	84.6	84.8	81.3	82.1	81.0	80.1	80.3	79.8	80.1	80.1	80.0
630	80.7	82.3	82.7	83.8	84.7	85.7	84.5	84.7	85.0	85.0	84.8	81.0	80.8	79.8	79.7	80.0	79.5	79.3	77.8	78.2
800	79.9	82.5	83.2	83.7	84.0	84.5	84.2	84.2	85.2	85.0	85.0	81.0	80.5	78.7	78.9	79.2	79.2	79.4	78.0	77.0
1 000	77.9	81.4	82.2	83.2	83.4	83.4	83.7	84.1	85.1	85.2	84.4	79.9	79.6	78.2	78.4	78.7	77.7	78.7	77.4	77.9
1 250	79.3	81.5	81.6	82.3	83.1	83.5	83.8	83.6	85.1	85.0	84.5	79.1	79.1	78.1	77.6	78.1	78.0	78.0	77.5	79.3
1 600	77.6	80.2	80.1	80.7	81.9	82.9	82.6	82.6	84.6	83.9	82.9	76.6	77.7	76.7	75.2	75.9	76.1	76.2	75.9	77.6
2 000	76.5	79.2	79.3	80.0	80.7	82.0	82.3	81.7	83.3	82.5	80.8	75.0	76.3	74.8	75.2	74.3	73.8	74.7	76.7	78.5
2 500	72.6	77.1	78.3	79.6	79.6	81.8	81.8	82.3	82.4	81.6	80.1	74.6	75.1	73.3	75.3	73.4	71.9	72.8	73.1	74.1
3 150	73.3	78.4	78.9	80.6	81.3	82.4	82.4	84.1	83.9	83.6	81.6	75.6	76.4	74.3	73.1	73.6	72.9	74.4	74.4	74.6
4 000	73.3	78.0	78.5	79.8	80.6	83.0	82.0	82.1	84.1	82.6	79.5	73.6	75.0	72.8	70.8	70.6	71.3	72.5	73.8	73.6
5 000	71.7	75.4	76.2	77.7	78.2	81.9	80.5	80.9	82.4	79.9	76.7	70.9	72.4	69.7	69.5	68.7	68.0	70.0	70.5	71.5
6 300	68.5	72.7	74.7	77.4	78.5	81.2	81.2	82.2	80.5	80.5	77.4	70.7	71.0	69.7	69.0	68.5	68.0	69.7	71.9	71.5
8 000	69.1	73.6	75.1	77.1	78.9	82.4	82.3	82.6	83.8	79.8	75.9	69.1	69.9	68.6	68.8	67.6	66.9	69.6	70.9	70.6
10 000	67.1	71.1	73.4	76.4	77.6	82.1	81.1	81.8	81.4	79.4	75.4	68.8	69.4	67.8	67.9	66.6	66.8	69.6	70.8	69.6
12 500	65.2	68.9	70.7	74.0	76.0	80.0	79.0	79.5	78.9	76.4	73.7	66.0	66.4	65.0	65.5	64.0	63.9	66.2	67.5	66.9
16 000	61.0	65.5	68.2	71.4	73.4	77.2	76.0	77.0	76.4	73.9	71.7	63.7	63.9	62.7	63.7	61.7	60.9	64.0	65.0	63.5
20 000	58.7	62.5	65.3	68.3	70.7	73.5	73.2	73.8	72.5	70.7	68.8	61.0	61.7	60.2	62.0	59.2	58.8	60.8	62.0	60.7
Overall	94.5	97.2	97.4	97.6	98.2	98.7	98.5	98.8	99.0	98.5	97.8	95.5	96.3	96.7	97.3	97.0	96.5	95.9	95.0	94.0

TABLE I. - Continued. ONE-THIRD-OCTAVE-BAND SOUND PRESSURE LEVEL ON 15.24-METER-RADIUS CIRCLE

FOR EXTERNALLY BLOWN FLAP WITH SEVEN-LOBE MIXER NOZZLE

[Sound pressure level referenced to 2×10^{-5} N/m^2. Data corrected for atmospheric attenuation (lossless).]

(k) Run 11. Flap setting, zero; nozzle pressure ratio, 1.69; nozzle exhaust velocity, 286 m/sec; nozzle temperature, 291 K; ambient temperature, 289 K; relative humidity, 52 percent; barometric pressure, 99.8×10^3 N/m^2.

Frequency, Hz	Angle, deg																			
	15	35	55	65	75	85	100	115	125	135	145	155	205	215	230	250	270	290	310	330
	Sound pressure level, dB																			
50	84.0	87.3	89.7	90.5	92.0	91.7	92.2	91.2	90.7	88.8	87.5	85.3	89.2	90.5	91.3	91.8	91.2	90.0	87.3	82.5
63	84.5	88.3	92.0	91.0	93.2	92.7	92.8	91.2	90.5	89.3	87.3	85.8	89.2	89.7	91.3	91.7	92.0	91.2	88.7	83.8
80	85.2	88.8	90.7	90.8	91.3	90.5	90.2	89.2	87.8	87.7	86.5	85.8	86.8	87.5	89.3	89.8	90.7	90.2	87.3	84.7
100	85.0	87.5	87.2	86.5	86.8	85.8	85.3	84.5	85.2	86.0	86.5	87.5	86.3	86.8	86.5	87.3	87.2	87.0	84.8	82.5
125	86.9	88.0	89.0	88.4	87.4	87.5	87.9	89.0	89.7	91.0	91.5	93.4	91.0	91.7	91.5	90.5	89.2	89.2	88.2	87.0
160	89.7	92.7	93.2	90.9	90.7	91.5	92.9	93.5	94.9	96.4	97.9	98.5	95.2	95.7	95.0	94.4	92.0	91.4	91.7	90.2
200	94.5	95.9	94.4	93.4	93.7	94.5	94.4	94.7	96.7	99.4	100.7	101.0	96.0	96.4	96.4	94.9	94.4	91.9	91.7	92.2
250	95.2	96.5	95.2	94.4	95.2	94.4	94.5	95.0	96.2	97.9	99.9	99.2	93.2	93.9	94.4	93.0	92.7	92.5	90.9	90.0
315	94.7	95.2	94.7	93.7	94.0	93.5	94.0	94.7	95.2	97.0	98.5	100.4	93.7	94.4	92.5	91.5	90.2	90.2	89.9	89.4
400	98.1	99.4	98.4	97.6	97.9	97.1	97.2	98.4	99.2	101.4	102.6	102.4	93.9	96.9	95.7	93.2	92.2	91.4	91.1	90.4
500	97.6	98.6	97.1	96.4	97.1	96.4	96.6	97.2	98.7	99.9	100.6	100.6	91.1	94.9	94.2	91.9	90.6	90.1	90.1	89.7
630	97.6	99.6	97.8	97.1	97.3	98.1	98.3	98.3	99.9	101.4	101.8	100.9	90.8	94.9	95.6	91.9	90.4	89.9	89.3	90.6
800	96.6	100.1	99.3	99.5	99.5	99.6	99.3	99.1	101.3	102.6	102.0	101.1	90.8	94.8	96.0	92.8	91.0	91.1	91.0	92.6
1 000	96.3	98.8	99.5	99.3	100.0	100.3	100.0	99.8	101.7	103.0	101.8	101.0	90.2	93.5	96.7	91.8	90.5	90.2	90.8	92.7
1 250	95.7	98.0	99.2	99.0	99.9	100.5	100.4	100.2	101.7	102.5	101.9	100.5	90.2	92.4	96.9	91.4	89.7	89.7	90.4	91.4
1 600	94.1	96.9	97.9	98.1	98.9	99.6	99.9	99.8	100.4	101.6	100.8	99.3	89.6	91.4	95.6	89.8	87.6	88.4	89.4	90.6
2 000	93.5	95.8	97.3	97.3	97.7	98.2	99.8	99.5	99.2	99.8	99.0	97.3	87.8	90.8	95.0	89.7	86.3	87.2	88.2	89.8
2 500	91.2	94.2	96.4	96.4	96.6	97.7	98.6	98.9	99.9	99.2	98.2	95.2	87.6	90.7	94.6	89.7	86.4	86.9	88.1	87.9
3 150	91.7	95.7	96.8	97.8	98.3	99.5	99.3	99.3	101.7	101.2	100.0	96.5	89.0	92.0	95.0	89.3	86.7	87.7	89.5	89.2
4 000	92.3	95.8	96.3	97.1	98.0	98.8	99.6	99.5	99.8	100.0	98.5	96.0	87.0	90.5	93.0	87.3	84.5	86.1	87.6	89.1
5 000	91.0	94.0	94.1	95.5	95.6	96.6	98.5	97.3	97.3	97.0	95.3	92.8	84.8	88.3	90.6	87.0	83.1	83.6	85.3	86.1
6 300	87.3	90.5	92.8	94.5	95.3	96.5	97.3	96.0	98.0	98.0	94.7	92.7	84.7	87.7	90.3	85.8	83.5	83.7	85.3	86.5
8 000	87.4	91.1	92.4	94.1	94.9	96.6	97.3	95.8	95.8	95.9	92.8	91.4	83.3	86.4	88.6	85.3	82.8	81.9	84.1	86.4
10 000	85.6	88.8	91.6	93.1	93.8	95.8	96.9	94.8	95.6	95.4	92.1	89.9	82.8	85.4	87.4	84.3	81.9	82.1	83.4	85.1
12 500	83.6	86.8	88.6	91.1	92.1	93.6	94.8	92.6	93.6	93.1	89.1	87.8	80.1	83.0	85.0	82.6	80.1	79.6	81.0	82.8
16 000	79.2	83.2	86.4	88.5	89.2	91.5	92.5	90.5	91.0	90.2	86.7	85.7	77.9	80.4	82.4	80.4	78.5	77.4	78.5	81.4
20 000	76.2	79.3	82.8	85.0	86.2	87.8	89.2	87.5	87.7	87.5	83.7	82.2	74.2	77.5	79.0	78.0	76.0	73.7	75.5	78.5
Overall	107.4	109.6	109.7	109.8	110.3	110.9	111.3	111.0	112.2	113.0	112.6	111.9	104.5	106.5	107.8	104.9	103.6	103.2	102.9	103.1

TABLE I. - Continued. ONE-THIRD-OCTAVE-BAND SOUND PRESSURE LEVEL ON 15.24-METER-RADIUS CIRCLE

FOR EXTERNALLY BLOWN FLAP WITH SEVEN-LOBE MIXER NOZZLE

[Sound pressure level referenced to 2×10^{-5} N/m^2. Data corrected for atmospheric attenuation (lossless).]

(l) Run 12. Flap setting, zero; nozzle pressure ratio, 1.48; nozzle exhaust velocity, 250 m/sec; nozzle temperature, 293 K; ambient temperature. 289 K; relative humidity, 52 percent; barometric pressure, 99.8×10^3 N/m^2.

Frequency, Hz	Angle, deg																			
	15	35	55	65	75	85	100	115	125	135	145	155	205	215	230	250	270	290	310	330
	Sound pressure level, dB																			
50	82.3	85.3	88.2	88.5	89.5	89.8	90.3	89.8	88.7	87.5	85.8	84.0	85.7	87.7	88.7	89.7	90.3	88.3	86.0	82.0
63	82.2	85.0	89.0	89.2	89.8	88.8	89.2	88.8	87.2	86.5	85.3	82.8	85.7	86.7	88.2	89.5	89.3	88.2	86.3	82.5
80	81.7	85.5	87.8	87.8	87.8	87.0	86.8	85.7	85.2	84.2	84.2	82.5	83.5	83.8	85.0	86.7	87.7	86.8	84.3	82.3
100	81.7	84.0	83.8	83.5	83.7	82.2	81.7	81.3	82.2	82.5	82.5	83.3	82.5	83.2	82.8	83.2	83.7	83.8	81.5	79.3
125	84.0	85.0	85.4	85.2	85.2	83.7	84.5	85.9	85.9	87.7	88.0	89.5	86.9	87.9	87.7	86.0	85.5	86.2	85.5	83.5
160	85.9	89.2	89.0	88.4	87.4	87.7	89.0	90.0	90.9	92.7	94.2	94.9	90.9	91.5	90.9	90.7	88.7	87.7	88.0	86.5
200	91.0	92.5	91.9	90.2	90.7	90.7	90.9	91.4	92.9	95.2	97.0	97.2	92.0	92.5	91.9	90.5	90.2	87.5	88.4	88.0
250	92.2	93.7	92.0	90.9	91.9	91.0	90.5	91.4	93.0	94.2	95.9	95.4	88.9	89.7	90.2	89.2	88.4	88.0	87.2	87.4
315	91.5	92.0	91.4	90.9	90.5	90.4	90.4	91.0	91.5	93.0	93.4	95.2	89.7	90.2	88.0	86.9	86.0	86.4	86.2	85.9
400	93.9	95.9	94.4	93.7	94.4	93.6	93.4	94.2	95.4	96.7	97.7	97.9	90.1	92.1	91.1	88.9	88.2	87.2	87.4	86.9
500	94.2	95.1	93.4	93.1	93.1	92.6	92.6	93.1	94.4	95.2	95.9	95.9	87.2	90.4	89.6	87.1	86.4	86.6	86.7	86.1
630	92.9	95.9	93.8	93.1	93.1	93.4	93.8	94.1	95.8	96.9	97.3	96.6	86.4	91.1	90.3	87.8	86.1	85.6	85.3	86.1
800	92.6	94.8	94.5	94.5	94.6	95.0	94.8	94.8	96.5	98.3	97.3	96.8	86.6	92.0	90.6	87.3	86.1	86.6	86.0	87.1
1 000	91.2	94.8	94.7	94.8	95.3	95.7	95.7	95.2	96.8	98.2	97.5	96.5	86.0	91.0	91.0	86.8	85.7	86.2	86.2	88.5
1 250	91.2	93.5	94.4	94.7	95.2	95.7	95.7	95.2	97.0	98.2	97.0	95.4	85.5	89.9	91.0	86.0	84.9	85.7	85.9	87.5
1 600	89.1	92.8	93.4	93.8	94.3	94.9	95.3	94.8	95.9	96.9	95.9	94.3	85.4	87.9	89.6	84.3	83.1	83.8	84.6	86.4
2 000	88.3	91.2	92.7	92.5	93.3	93.7	94.5	94.7	94.7	95.2	94.2	92.3	83.7	86.5	88.7	83.5	81.5	82.3	83.8	86.2
2 500	85.4	88.9	91.9	91.7	91.9	92.9	93.7	93.6	95.2	94.1	93.2	89.9	83.1	86.1	88.6	84.1	81.4	82.1	83.6	83.1
3 150	86.3	90.2	91.8	82.5	93.8	95.2	94.5	94.3	96.7	96.3	94.8	91.7	83.8	87.2	89.5	83.7	82.0	83.2	85.0	84.7
4 000	86.8	90.3	91.5	92.1	93.0	94.3	95.1	94.1	95.0	95.0	93.6	90.6	82.0	85.8	87.1	81.1	79.3	81.3	83.3	84.6
5 000	85.1	88.3	89.6	90.3	90.5	91.8	94.1	92.3	93.0	92.1	90.6	87.6	80.0	83.8	84.8	80.6	78.0	79.3	81.6	81.8
6 300	81.8	85.7	87.7	89.7	90.8	92.3	92.8	91.7	93.2	93.2	89.5	87.5	79.5	82.7	84.8	79.5	78.2	79.5	82.0	82.3
8 000	81.8	86.4	87.9	88.9	90.4	92.1	93.1	90.9	91.4	91.6	87.8	86.4	78.1	81.1	83.1	78.8	77.6	78.3	80.9	82.3
10 000	80.4	83.9	86.6	88.3	89.8	91.8	92.8	89.9	91.3	90.6	87.3	85.1	77.9	80.9	81.9	77.9	76.8	78.6	80.6	81.3
12 500	78.3	82.1	84.0	86.1	88.3	89.8	91.1	88.3	89.5	88.3	84.1	83.0	75.5	78.0	79.6	76.6	75.0	76.8	78.1	79.1
16 000	74.9	78.7	82.0	84.0	85.7	87.5	88.9	85.9	86.7	85.9	81.9	80.4	73.2	76.0	76.9	74.5	73.4	74.2	76.2	78.0
20 000	71.3	75.0	78.3	80.7	82.2	83.7	85.2	83.0	83.5	82.7	78.5	77.3	69.3	72.7	73.5	71.8	70.7	70.2	72.0	75.2
Overall	103.2	105.5	105.5	105.5	106.0	106.5	106.9	106.5	107.7	108.5	108.1	107.4	100.4	102.6	102.7	100.6	99.8	99.3	99.2	99.2

TABLE I. - Continued. ONE-THIRD-OCTAVE-BAND SOUND PRESSURE LEVEL ON 15.24-METER-RADIUS CIRCLE

FOR EXTERNALLY BLOWN FLAP WITH SEVEN-LOBE MIXER NOZZLE

[Sound Pressure level referenced to 2×10^{-5} N/m^2. Data corrected for atmospheric attenuation (lossless).]

(m) Run 13. Flap setting, zero; nozzle pressure ratio, 1.39; nozzle exhaust velocity, 231 m/sec; nozzle temperature, 296 K; ambient temperature, 289 K; relative humidity, 52 percent; barometric pressure, 99.8×10^3 N/m^2.

Frequency, Hz	Angle, deg																			
	15	35	55	65	75	85	100	115	125	135	145	155	205	215	230	250	270	290	310	330
	Sound pressure level, dB																			
50	80.3	83.8	86.8	86.7	88.3	87.8	88.3	88.0	87.2	86.2	84.2	82.2	83.8	86.0	87.2	88.5	87.5	87.2	83.7	80.0
63	80.2	83.7	87.0	87.2	88.0	87.7	87.8	85.7	86.2	84.5	82.8	81.5	83.2	84.3	85.8	87.2	86.7	86.7	84.7	80.3
80	79.8	83.0	85.2	85.7	85.3	85.5	84.0	82.7	82.5	81.8	81.3	80.8	81.2	81.3	82.8	84.3	84.5	85.0	82.0	80.5
100	79.8	81.2	81.3	80.2	81.2	80.3	78.8	78.3	78.5	79.3	80.0	80.7	80.2	80.3	79.8	80.8	81.3	81.0	79.7	77.7
125	83.4	82.5	82.4	83.2	82.9	81.2	82.9	83.4	84.0	85.5	86.2	88.0	85.0	84.9	85.2	83.5	83.2	84.0	83.7	81.9
160	83.7	86.7	87.0	85.4	84.5	85.5	87.0	87.2	88.9	90.5	91.7	93.0	88.9	89.0	88.4	88.2	86.0	85.4	85.7	84.2
200	88.5	90.7	89.4	88.2	88.2	88.7	88.7	89.2	90.9	93.0	94.2	94.7	89.5	89.7	89.2	87.5	88.0	85.0	86.2	85.7
250	89.9	91.5	89.9	89.5	89.5	89.0	89.0	89.0	89.9	91.9	93.0	92.7	86.5	87.0	87.2	86.0	86.0	85.9	84.9	85.2
315	89.4	89.5	88.7	88.0	88.2	87.9	87.9	89.2	89.9	90.7	91.0	92.5	87.2	87.2	85.5	84.2	83.7	83.9	83.9	83.7
400	91.9	93.4	92.1	91.2	91.9	91.2	91.2	92.4	92.9	94.2	94.7	95.2	87.6	89.2	87.9	86.1	85.6	84.7	84.6	84.7
500	91.7	92.9	90.6	90.4	90.4	90.4	90.1	90.9	92.4	93.1	92.7	93.2	84.9	88.1	86.2	84.6	84.1	84.1	84.9	83.9
630	89.9	92.9	90.8	90.4	90.4	90.9	91.1	91.4	93.4	94.1	94.4	94.1	83.3	88.6	87.3	84.4	83.6	83.3	83.1	83.4
800	90.0	92.0	91.3	91.5	91.8	92.5	92.1	92.1	94.0	94.8	94.6	94.5	83.6	89.3	87.0	84.1	83.3	83.6	83.0	83.6
1 000	88.0	91.8	91.8	92.0	92.5	93.0	92.7	92.7	94.2	95.3	94.5	94.0	82.7	88.5	87.3	83.3	82.7	83.2	83.0	86.2
1 250	88.2	90.9	91.9	92.2	92.2	93.0	92.7	92.7	94.0	94.7	94.0	93.0	82.4	87.9	87.0	82.9	81.9	83.2	83.0	84.7
1 600	86.3	89.4	90.6	91.1	91.1	92.3	92.1	92.3	92.9	93.6	92.8	91.6	81.9	85.6	86.1	81.1	80.3	81.3	81.9	83.6
2 000	85.5	88.2	89.7	89.7	90.2	90.7	92.0	91.7	91.8	91.8	90.5	90.0	80.5	84.3	84.8	80.5	79.2	79.7	81.3	83.5
2 500	82.9	85.9	88.6	88.6	89.1	90.2	90.9	91.1	91.9	90.9	89.9	87.2	79.6	83.6	85.1	80.2	78.2	79.6	80.9	80.6
3 150	83.3	87.2	89.0	90.2	90.7	92.2	91.5	91.5	93.8	83.2	91.7	88.8	80.5	84.2	85.7	79.7	78.7	80.5	82.5	81.8
4 000	83.8	87.5	88.6	89.1	90.3	91.3	92.0	91.5	92.0	91.6	90.3	88.3	79.0	83.1	83.6	77.5	76.5	78.6	80.6	81.8
5 000	82.5	85.5	86.5	87.3	87.5	89.1	90.8	89.5	89.8	89.0	87.3	85.1	77.0	81.0	81.3	77.0	74.6	76.6	78.8	78.8
6 300	79.2	82.3	84.8	87.0	87.3	89.7	90.0	88.7	90.2	89.8	86.5	85.2	76.3	79.8	81.3	75.7	75.3	77.0	79.3	79.8
8 000	79.4	83.4	84.8	86.4	87.3	90.1	90.6	88.3	88.6	88.3	84.9	83.9	74.9	78.3	79.8	75.4	74.6	76.4	78.8	79.6
10 000	78.1	81.4	83.9	85.8	86.8	89.8	90.4	87.8	88.4	87.8	84.6	82.4	74.9	77.8	78.3	74.4	74.4	77.1	78.6	78.8
12 500	76.0	79.3	81.6	84.0	85.0	88.1	88.5	85.8	86.6	85.8	81.3	80.3	72.1	75.3	76.1	72.5	72.5	74.8	76.6	77.0
16 000	72.5	76.2	79.2	81.2	82.9	85.4	86.0	83.5	84.0	82.9	78.4	77.9	70.0	73.0	73.7	70.2	70.5	72.4	74.2	76.0
20 000	69.0	72.3	75.8	78.0	79.2	81.5	82.5	80.5	80.5	79.5	75.2	74.7	66.2	69.7	69.8	67.5	67.7	68.3	70.7	72.5
Overall	100.7	102.9	102.8	102.9	103.3	104.1	104.2	104.0	105.1	105.6	105.1	104.9	97.8	100.0	99.6	97.8	97.2	97.1	96.9	96.8

TABLE I. - Continued. ONE-THIRD-OCTAVE-BAND SOUND PRESSURE LEVEL ON 15.24-METER-RADIUS CIRCLE

FOR EXTERNALLY BLOWN FLAP WITH SEVEN-LOBE MIXER NOZZLE

[Sound pressure level referenced to 2×10^{-5} N/m^2. Data corrected for atmospheric attenuation (lossless).]

(n) Run 14. Flap setting, zero; nozzle pressure ratio, 1.29; nozzle exhaust velocity, 204 m/sec; nozzle temperature, 295 K; ambient temperature, 289 K; relative humidity, 52 percent; barometric pressure, 99.8×10^3 N/m^2.

Frequency, Hz	Angle, deg																			
	15	35	55	65	75	85	100	115	125	135	145	155	205	215	230	250	270	290	310	330
	Sound pressure level, dB																			
50	78.0	82.2	84.0	85.0	85.7	87.0	86.3	85.0	84.7	83.8	81.8	79.3	81.2	83.0	84.5	85.7	85.7	84.7	81.2	76.5
63	76.8	81.3	83.3	84.5	84.5	85.5	84.2	83.3	82.7	81.5	79.5	78.3	80.0	80.7	82.8	84.2	83.7	83.5	81.3	76.8
80	78.2	81.0	82.5	81.8	82.2	82.5	81.0	79.7	79.5	78.5	78.0	77.0	78.3	79.0	79.8	81.0	82.2	81.8	80.2	78.0
100	77.5	79.3	79.0	78.7	77.2	77.7	75.8	75.3	76.3	76.2	76.7	77.7	76.3	76.3	76.7	77.5	78.2	78.0	76.2	74.8
125	82.2	80.7	80.4	81.0	80.5	79.0	80.4	81.4	80.7	82.7	83.4	84.7	81.7	81.7	81.7	81.2	81.2	81.9	82.0	79.4
160	81.2	84.5	84.4	82.7	81.7	82.0	83.2	84.5	85.5	87.5	88.7	89.0	85.4	85.5	85.2	84.5	82.5	82.5	83.0	81.4
200	85.7	88.2	86.4	85.0	85.0	85.4	85.5	85.7	87.7	89.5	90.5	91.0	86.4	85.9	85.2	84.0	84.2	81.9	82.9	83.0
250	87.4	89.0	87.5	86.7	85.9	85.9	85.9	85.9	87.0	87.7	89.4	88.9	82.4	82.9	83.7	82.7	82.5	83.0	82.2	82.4
315	86.2	86.2	85.9	85.0	85.0	84.9	84.7	85.7	86.4	87.0	87.4	88.2	83.9	83.5	81.9	81.0	80.4	80.7	80.7	80.9
400	88.7	89.9	89.2	87.6	88.6	88.2	87.4	88.7	89.4	90.2	90.7	90.4	84.2	85.4	83.6	82.4	82.1	81.6	81.7	81.7
500	88.9	89.7	87.6	86.7	87.1	86.4	86.9	87.4	88.1	88.9	89.1	88.7	81.9	83.9	81.9	80.9	80.4	80.6	81.1	80.4
630	85.4	88.4	87.1	86.8	86.4	87.1	87.6	87.4	89.4	89.6	90.1	89.4	79.8	84.3	82.6	80.1	79.8	79.6	79.3	79.4
800	85.6	88.3	88.0	87.1	87.6	88.0	88.1	88.1	89.8	90.5	90.3	89.6	79.8	85.0	82.6	79.8	78.8	79.3	79.6	79.6
1 000	83.8	86.7	87.7	87.5	87.8	88.7	88.7	88.3	90.0	90.7	90.3	89.5	79.0	85.0	82.2	78.8	78.5	79.2	78.8	81.5
1 250	83.7	86.4	87.9	87.7	87.7	88.5	88.9	88.5	89.9	90.0	89.7	88.4	78.4	84.5	82.0	78.5	78.0	79.2	79.0	80.9
1 600	82.1	85.3	86.8	86.6	87.3	87.8	88.3	87.9	88.6	89.3	88.8	86.9	77.6	82.6	80.6	76.6	75.9	77.3	77.9	79.4
2 000	81.2	84.2	86.0	85.5	86.0	86.2	87.7	87.3	87.3	87.0	86.2	85.0	76.2	80.8	79.7	76.0	74.8	75.5	77.2	79.2
2 500	78.2	81.9	84.6	84.4	84.7	85.4	86.9	86.2	87.4	86.4	85.2	82.7	75.2	80.1	79.6	76.2	74.2	75.4	76.9	76.2
3 150	78.8	83.2	84.8	85.7	86.7	87.7	87.5	87.2	89.5	88.7	87.2	83.8	76.3	80.5	80.2	75.3	74.3	76.7	79.0	77.3
4 000	79.3	83.3	84.8	85.0	85.5	87.3	88.3	87.5	87.6	87.1	85.6	83.1	74.8	78.6	77.8	72.6	71.8	75.0	76.8	77.5
5 000	77.8	81.1	82.6	83.1	83.3	85.1	87.1	85.3	85.3	84.3	82.8	80.0	72.3	76.8	75.8	72.0	70.5	72.8	74.8	74.6
6 300	74.7	78.5	81.3	82.5	83.5	85.5	86.3	84.7	85.8	85.5	82.3	80.0	72.2	75.7	75.7	70.7	71.0	73.3	75.7	75.3
8 000	74.9	79.6	81.3	82.3	83.6	86.4	87.6	85.1	84.9	84.3	80.9	78.8	70.9	74.3	74.4	70.4	71.1	73.1	75.4	75.4
10 000	73.4	77.4	80.4	82.3	83.1	86.1	87.4	84.1	84.9	83.6	80.3	78.1	70.6	73.8	73.6	69.4	70.6	73.8	75.4	74.6
12 500	71.6	75.8	78.0	79.8	81.3	84.1	85.1	82.5	83.0	81.3	77.1	75.8	68.5	71.0	71.0	67.6	68.8	72.0	73.1	72.5
16 000	67.9	72.5	75.7	77.2	78.7	81.2	83.2	80.0	79.9	78.9	74.9	73.5	65.7	68.5	68.5	65.4	66.9	69.2	70.4	71.4
20 000	64.8	68.5	71.8	73.8	75.5	77.7	79.2	76.5	76.8	75.5	71.5	70.2	62.0	65.2	64.7	62.7	63.5	65.3	66.8	67.8
Overall	97.2	99.3	99.4	99.1	99.4	100.2	100.7	100.1	101.1	101.4	101.1	100.5	94.3	96.3	95.4	94.3	93.9	93.9	93.7	93.2

TABLE I. - Continued. ONE-THIRD-OCTAVE-BAND SOUND PRESSURE LEVEL ON 15.24-METER-RADIUS CIRCLE

FOR EXTERNALLY BLOWN FLAP WITH SEVEN-LOBE MIXER NOZZLE

[Sound pressure level referenced to 2×10^{-5} N/m^2. Data corrected for atmospheric attenuation (lossless).]

(o) Run 15. Flap setting, zero; nozzle pressure ratio, 1.19; nozzle exhaust velocity, 170 m/sec; nozzle temperature, 296 K; ambient temperature, 289 K; relative humidity, 52 percent; barometric pressure, 99.8×10^3 N/m^2.

Frequency, Hz	Angle, deg																			
	15	35	55	65	75	85	100	115	125	135	145	155	205	215	230	250	270	290	310	330
	Sound pressure level, dB																			
50	74.0	77.8	80.7	80.2	81.0	81.8	81.5	80.2	80.0	78.5	78.0	76.0	76.0	78.0	79.2	81.3	80.8	80.0	77.7	73.3
63	74.5	77.0	79.3	79.7	79.5	80.7	79.7	78.3	78.0	76.7	75.7	74.7	73.8	76.0	77.7	78.5	79.3	78.8	77.2	72.8
80	73.8	75.7	77.3	77.5	77.7	78.7	77.3	76.3	75.7	75.3	75.2	74.5	74.7	75.3	75.8	76.5	78.7	77.5	76.5	75.5
100	73.7	73.7	73.2	73.8	72.8	72.5	72.0	72.2	71.8	72.8	73.0	73.8	71.3	72.0	71.5	72.0	73.3	74.0	72.8	72.3
125	81.0	75.4	76.9	78.7	77.9	75.7	78.2	78.4	77.7	79.5	79.9	81.4	76.5	77.9	79.0	76.4	78.4	80.5	80.7	77.9
160	77.0	79.2	79.2	78.9	77.5	77.5	78.7	80.9	82.2	83.9	84.4	84.7	80.4	80.9	79.5	80.2	77.4	78.4	78.4	76.2
200	81.2	83.2	82.2	81.4	81.0	81.4	81.4	81.5	83.5	85.2	86.4	86.4	80.9	80.9	80.2	79.4	79.9	77.4	78.9	79.0
250	83.0	84.0	82.5	82.0	81.9	81.5	81.2	81.5	82.2	83.7	85.2	84.2	76.9	77.7	78.4	77.5	78.4	78.0	77.5	78.0
315	80.9	81.0	80.4	80.2	80.4	80.4	80.2	80.9	81.4	81.4	82.0	82.9	77.9	77.5	76.5	75.7	75.5	76.0	76.7	76.0
400	83.6	84.7	83.6	83.1	83.6	83.2	82.6	83.6	84.6	84.7	85.4	84.7	78.6	79.2	78.2	77.1	77.4	77.1	77.2	78.1
500	83.4	83.9	82.1	81.7	81.6	81.2	81.4	82.1	83.1	83.6	83.4	83.1	76.4	77.9	76.1	75.7	75.6	75.9	77.2	76.4
630	79.4	81.9	80.6	80.8	81.1	81.3	81.8	82.1	83.4	83.9	83.6	83.1	74.4	78.3	76.1	74.9	74.4	74.8	74.8	75.1
800	79.1	81.5	81.0	81.3	81.6	82.0	82.3	82.3	83.8	84.5	84.0	83.1	74.0	78.6	75.5	74.0	73.6	74.1	74.8	74.6
1 000	78.5	80.8	81.0	81.2	82.2	82.2	82.5	82.5	83.8	84.7	83.8	82.5	73.0	78.7	75.2	72.7	72.8	73.5	73.8	75.7
1 250	78.7	80.7	81.9	82.0	82.0	82.9	82.7	82.7	84.0	84.0	83.4	82.0	72.7	78.5	75.0	72.7	72.9	74.5	74.7	76.9
1 600	77.4	79.3	80.8	80.8	80.8	81.8	81.9	81.6	82.4	82.6	81.9	80.4	71.8	77.3	73.6	70.9	70.8	73.4	73.6	75.3
2 000	75.7	77.7	79.3	79.3	79.5	80.2	81.2	81.0	81.2	80.7	79.8	78.5	70.3	75.2	72.2	69.8	69.8	70.8	73.2	76.2
2 500	72.1	75.2	78.2	78.4	78.4	79.7	80.7	80.6	81.2	79.9	79.2	76.1	69.2	74.4	71.6	69.4	67.9	69.9	71.9	71.7
3 150	72.8	76.7	78.7	79.7	80.2	82.0	81.7	81.0	83.0	82.0	80.8	77.2	70.0	74.8	72.2	68.5	68.5	71.2	73.2	71.8
4 000	73.5	77.1	78.1	78.8	79.6	81.5	82.1	81.5	81.6	81.1	79.1	76.6	68.1	72.8	70.5	66.0	66.0	69.5	71.6	72.0
5 000	72.1	74.6	76.0	77.1	77.3	79.6	81.5	80.0	80.0	78.5	76.6	74.1	66.1	71.1	68.1	65.1	64.6	67.6	69.6	69.1
6 300	68.7	72.0	74.7	76.7	77.7	80.8	81.2	80.0	81.0	80.3	76.2	74.2	66.0	69.8	68.3	64.2	65.7	68.5	70.8	70.2
8 000	69.4	73.8	75.8	76.6	78.3	82.3	83.3	81.3	81.1	80.3	75.1	73.6	65.8	68.9	67.8	64.6	65.8	68.6	70.6	70.6
10 000	68.1	71.4	74.3	76.6	77.8	81.9	82.9	79.9	80.8	79.1	74.8	72.6	65.3	68.6	66.8	63.3	65.3	68.9	70.3	69.9
12 500	66.0	69.3	71.8	73.8	75.3	79.3	80.5	78.0	78.3	76.8	71.8	70.0	62.5	65.8	64.1	60.8	63.0	66.6	67.3	67.5
16 000	62.4	66.2	69.5	71.2	72.9	76.9	77.9	75.0	75.2	73.7	68.9	67.4	59.7	62.3	61.5	58.2	60.4	63.5	64.5	65.5
20 000	58.8	61.7	65.7	68.2	69.7	72.8	73.5	71.3	71.7	70.0	65.5	64.2	56.2	58.7	57.5	54.8	57.2	59.0	60.8	62.0
Overall	92.3	93.7	93.7	93.8	94.1	95.0	95.3	94.9	95.8	95.9	95.6	94.9	88.9	90.8	89.7	89.2	89.4	89.5	89.6	89.1

TABLE I. - Continued. ONE-THIRD-OCTAVE-BAND SOUND PRESSURE LEVEL ON 15.24-METER-RADIUS CIRCLE

FOR EXTERNALLY BLOWN FLAP WITH SEVEN-LOBE MIXER NOZZLE

[Sound pressure level referenced to 2×10^{-5} N/m^2. Data corrected for atmospheric attenuation (lossless).]

(p) Run 16. Nozzle alone; nozzle pressure ratio, 1.7; nozzle exhaust velocity, 285 m/sec; nozzle temperature, 286 K; ambient temperature, 279 K; relative humidity, 65 percent; barometric pressure, 99.7×10^3 N/m^2.

Frequency, Hz	Angle, deg																			
	15	35	55	70	85	100	115	125	135	145	155	165	205	215	230	250	270	290	310	330
	Sound pressure level, dB																			
50	74.0	76.0	75.3	75.7	76.2	74.5	77.2	78.5	79.7	82.3	84.7	86.5	85.2	82.5	79.5	76.5	76.3	75.3	73.7	73.2
63	74.7	75.5	75.2	75.5	76.3	75.3	77.7	78.7	80.3	82.5	84.2	85.7	84.8	82.8	78.7	76.8	77.2	75.3	74.0	73.3
80	75.5	76.2	76.8	75.5	76.5	74.5	78.0	78.8	80.7	83.0	83.5	83.8	84.8	82.7	79.3	77.8	77.0	76.0	75.2	75.5
100	77.4	78.9	76.3	76.4	77.2	74.9	78.7	80.5	83.4	85.9	87.9	88.0	86.7	84.9	82.0	79.0	77.2	77.4	76.9	77.4
125	82.2	80.5	80.9	81.5	83.0	80.5	84.0	85.9	89.0	91.9	94.4	94.4	93.2	91.0	86.5	84.5	83.9	86.7	84.7	81.2
160	81.9	83.2	84.7	85.2	86.4	84.9	88.7	90.0	93.2	96.5	98.4	97.4	98.7	96.0	91.0	87.5	85.9	84.2	83.5	82.4
200	86.2	86.4	87.5	88.2	89.2	86.7	90.7	92.9	96.0	99.4	99.9	97.2	100.4	98.0	93.7	90.0	88.9	87.0	85.7	86.0
250	87.0	88.2	87.2	88.0	88.7	86.7	89.9	92.5	95.5	97.5	96.9	96.0	97.9	96.9	92.9	89.2	88.7	87.9	86.0	85.2
315	86.1	86.7	87.1	87.2	88.9	88.1	91.7	93.2	96.7	99.6	100.1	97.4	97.7	98.9	93.7	90.6	88.1	87.4	85.6	85.2
400	90.1	89.4	91.1	91.6	92.6	90.7	94.6	96.6	99.9	102.6	102.2	99.4	101.9	102.4	97.7	93.7	92.7	91.6	89.9	88.7
500	89.6	90.3	90.3	90.8	91.6	90.1	94.1	96.4	98.8	99.9	100.3	97.4	99.4	100.9	97.3	93.8	91.9	90.4	89.3	88.3
630	90.1	91.1	91.3	91.8	93.4	91.6	94.9	97.9	100.4	101.4	101.1	97.6	100.3	101.9	99.3	95.6	93.8	92.8	90.8	90.3
800	91.5	93.0	92.6	93.6	95.1	93.3	96.8	99.6	101.1	101.8	100.6	97.1	100.0	102.1	100.8	96.8	94.8	94.0	92.5	92.8
1 000	90.4	93.4	93.5	93.9	95.7	94.2	97.0	100.2	102.0	101.5	99.7	97.5	99.5	101.9	101.5	97.5	95.5	94.5	93.4	92.9
1 250	92.1	94.1	93.9	94.1	96.1	94.4	97.4	100.6	102.1	101.1	98.7	97.1	99.6	101.2	102.4	97.4	96.1	94.7	94.1	93.4
1 600	92.0	94.0	94.0	94.1	95.3	94.8	97.5	99.5	101.5	99.6	97.1	95.6	97.8	99.6	101.5	97.0	95.1	94.1	93.6	93.5
2 000	91.7	93.7	94.0	93.0	94.7	94.5	97.7	99.2	100.4	97.7	95.5	94.0	96.2	98.5	100.5	98.0	95.0	93.2	93.2	93.2
2 500	90.5	93.1	94.1	92.8	95.0	94.1	97.5	100.6	99.5	98.3	95.6	93.1	95.3	98.8	100.6	98.8	95.6	93.6	93.6	91.6
3 150	92.1	94.9	94.7	94.7	97.1	95.2	98.6	101.6	101.2	99.2	96.1	94.4	96.4	100.1	101.9	97.1	97.1	95.4	95.4	93.2
4 000	92.9	94.2	94.7	94.7	96.4	95.6	97.7	98.6	100.4	96.4	92.4	91.4	94.4	98.1	100.4	97.4	95.7	94.6	93.9	93.7
5 000	90.8	92.1	93.1	93.3	94.8	93.8	96.3	97.3	98.1	94.4	91.4	89.4	91.8	96.1	97.8	96.6	94.3	92.9	92.6	91.1
6 300	87.0	91.5	91.7	92.8	95.0	92.8	96.0	97.7	96.2	93.8	91.0	89.0	91.7	94.8	98.3	96.7	95.0	93.5	92.7	89.2
8 000	87.3	90.6	91.1	92.5	95.0	93.0	95.1	96.8	96.8	92.0	89.8	87.0	88.8	93.3	96.3	96.0	94.0	92.1	91.0	88.8
10 000	84.5	88.7	89.7	92.2	94.3	93.0	94.3	95.0	94.7	91.0	87.8	86.3	88.7	92.8	95.5	95.5	94.0	92.2	90.5	86.8
12 500	83.8	85.6	87.3	89.6	92.5	90.5	92.8	94.3	92.1	89.0	86.1	84.3	85.8	89.6	93.1	94.1	92.3	90.0	88.0	84.3
16 000	79.6	82.6	84.5	87.8	90.3	88.6	90.1	91.0	90.1	86.6	83.3	81.1	83.0	88.0	90.3	92.8	90.3	87.3	85.5	82.0
20 000	76.5	79.5	81.9	84.5	87.2	85.5	87.9	88.5	86.9	83.7	80.4	77.7	79.7	85.0	87.7	90.7	87.7	84.0	82.0	79.0
Overall	102.9	104.8	105.1	105.5	107.3	105.9	108.8	111.1	112.3	112.0	111.1	108.8	110.9	112.3	112.0	109.0	107.2	105.8	104.9	103.8

TABLE I. - Continued. ONE-THIRD-OCTAVE-BAND SOUND PRESSURE LEVEL ON 15.24-METER-RADIUS CIRCLE

FOR EXTERNALLY BLOWN FLAP WITH SEVEN-LOBE MIXER NOZZLE

[Sound pressure level referenced to 2×10^{-5} N/m^2. Data corrected for atmospheric attenuation (lossless).]

(q) Run 17. Nozzle alone; nozzle pressure ratio, 1.5; nozzle exhaust velocity, 254 m/sec; nozzle temperature, 292 K; ambient temperature, 279 K; relative humidity, 65 percent; barometric pressure, 99.7×10^3 N/m^2.

Frequency, Hz	Angle, deg																			
	15	35	55	70	85	100	115	125	135	145	155	165	205	215	230	250	270	290	310	330
	Sound pressure level, dB																			
50	71.2	70.5	71.7	70.8	73.7	71.0	74.2	74.7	76.7	79.3	80.8	84.7	81.7	78.5	75.8	73.7	72.8	70.8	70.3	69.8
63	71.8	71.7	71.5	72.0	73.0	71.5	74.2	76.0	77.3	79.7	80.2	83.8	81.2	79.0	76.0	73.7	73.5	72.3	71.2	70.7
80	73.0	73.3	72.5	72.7	73.2	71.2	74.3	75.3	78.0	79.5	80.0	82.8	80.5	78.8	76.8	74.7	74.3	73.5	73.0	73.2
100	74.9	75.2	73.2	72.9	73.7	72.0	76.0	77.0	79.5	81.9	84.2	84.9	82.5	81.4	77.9	75.5	74.4	75.4	74.2	74.9
125	81.5	78.4	77.4	79.2	80.9	77.9	81.5	82.7	85.0	88.7	90.5	91.0	89.9	88.0	83.9	81.9	82.2	86.4	83.7	80.4
160	78.9	79.4	80.4	81.0	83.0	81.5	85.9	87.4	89.7	93.2	94.5	94.2	94.4	92.4	87.5	84.7	82.4	80.9	80.0	78.5
200	82.2	82.0	83.9	84.4	85.7	84.4	88.0	90.0	93.0	95.2	96.4	93.9	96.5	94.4	90.0	86.7	85.0	83.7	82.4	82.4
250	82.9	84.4	83.7	84.4	85.4	83.4	87.2	89.0	91.0	93.9	93.2	92.0	94.0	92.7	89.2	85.7	85.0	84.2	82.2	81.4
315	82.1	82.9	83.4	83.9	84.9	83.9	88.2	89.6	92.7	94.1	95.4	92.6	93.7	94.1	90.2	86.7	84.6	83.9	81.7	81.9
400	86.1	85.6	87.4	87.2	89.2	87.1	91.2	93.4	95.6	98.2	97.2	94.9	97.4	97.2	93.6	90.4	89.1	88.1	86.2	84.7
500	85.6	85.9	86.6	87.1	87.9	86.4	90.4	92.8	94.6	95.4	94.6	92.9	94.3	95.9	92.8	89.9	88.1	86.3	86.1	84.6
630	85.9	87.1	87.4	88.1	89.9	88.3	91.3	93.9	96.1	96.9	96.3	92.6	95.3	97.1	94.8	91.8	89.9	88.9	87.4	86.4
800	86.8	88.8	88.8	89.8	91.3	90.0	93.0	95.3	97.0	97.6	96.3	92.8	95.0	97.5	96.5	93.0	91.5	89.8	88.6	88.0
1 000	87.2	89.9	89.7	90.4	91.9	90.2	93.5	96.0	97.2	97.4	95.5	93.2	94.7	97.2	97.4	93.4	92.0	91.0	89.9	89.2
1 250	88.4	90.4	90.2	90.7	92.1	90.4	93.4	96.2	97.4	96.9	94.1	92.7	94.2	96.7	97.6	93.2	92.1	90.9	90.1	89.6
1 600	87.8	89.6	89.8	90.0	91.6	90.3	93.5	95.1	96.6	95.1	92.3	91.6	93.0	95.3	97.0	93.0	91.3	90.0	89.3	89.0
2 000	87.2	89.4	89.9	89.0	90.9	90.4	93.5	94.5	95.2	93.0	90.4	89.4	91.4	94.2	96.0	93.7	90.7	89.4	88.5	88.9
2 500	85.5	88.3	89.3	89.0	90.6	89.8	93.5	96.0	94.5	93.6	90.6	88.8	90.6	94.3	95.8	94.3	91.3	89.1	89.0	87.0
3 150	87.1	89.9	90.4	90.6	92.7	91.2	94.1	96.7	96.4	94.4	91.4	89.7	91.7	95.2	97.2	92.6	92.7	91.2	90.2	87.6
4 000	87.2	89.4	90.2	90.4	92.1	91.2	93.6	93.9	95.6	92.1	87.6	86.4	89.9	93.7	95.9	93.2	91.2	90.4	88.7	88.1
5 000	85.6	86.9	88.1	88.3	90.3	89.6	91.9	92.9	93.3	89.8	87.1	84.9	86.9	91.3	93.3	92.3	89.4	88.1	87.4	85.8
6 300	81.8	86.2	86.8	88.0	90.5	88.3	91.8	93.2	91.2	89.5	86.2	84.3	87.0	90.2	93.7	92.2	90.5	88.7	87.5	84.3
8 000	82.5	85.5	86.1	87.8	90.5	88.5	91.1	92.5	91.6	87.6	85.1	82.3	84.3	88.8	92.0	91.8	89.6	87.6	86.0	84.0
10 000	80.2	83.5	84.8	87.7	90.3	88.5	90.2	90.8	90.0	86.5	83.0	81.3	83.7	88.2	91.3	91.3	89.7	87.3	85.8	82.3
12 500	79.0	80.6	82.8	85.0	88.5	85.8	88.3	89.8	87.5	84.0	81.1	79.1	80.8	85.3	88.8	89.8	87.6	84.8	83.5	79.8
16 000	75.3	78.1	80.1	82.8	85.8	84.3	86.0	86.6	85.6	81.6	78.3	76.0	77.6	83.1	86.3	88.5	86.0	82.3	80.8	77.8
20 000	72.0	75.0	77.4	80.0	82.7	80.9	83.0	84.2	81.7	78.4	75.9	72.7	75.0	80.0	83.0	86.5	83.0	80.0	77.5	75.0
Overall	98.5	100.4	100.9	101.4	103.3	101.8	104.9	106.8	107.7	107.6	106.5	104.6	106.3	107.7	107.6	104.9	103.1	101.7	100.6	99.4

TABLE I. - Continued. ONE-THIRD-OCTAVE-BAND SOUND PRESSURE LEVEL ON 15.24-METER-RADIUS CIRCLE

FOR EXTERNALLY BLOWN FLAP WITH SEVEN-LOBE MIXER NOZZLE

[Sound pressure level referenced to 2×10^{-5} N/m^2. Data corrected for atmospheric attenuation (lossless).]

(r) Run 18. Nozzle alone: nozzle pressure ratio, 1.41; nozzle exhaust velocity, 234 m/sec; nozzle temperature, 292 K; ambient temperature, 279 K; relative humidity, 65 percent; barometric pressure, 99.7×10^3 N/m^2.

Frequency, Hz	Angle, deg																			
	15	35	55	70	85	100	115	125	135	145	155	165	205	215	230	250	270	290	310	330
	Sound pressure level, dB																			
50	68.7	68.7	68.7	69.3	70.3	68.3	71.5	72.8	74.0	75.7	77.7	81.2	78.7	76.8	73.3	71.0	71.3	69.8	68.5	67.7
63	69.8	69.8	70.0	69.8	70.8	68.8	72.2	73.2	75.0	76.5	77.5	80.5	78.5	76.3	73.8	71.7	72.3	70.7	69.3	68.7
80	71.2	71.7	71.3	69.7	71.2	69.2	72.8	73.7	75.2	76.3	77.2	78.8	78.7	77.2	74.8	73.7	73.0	71.3	72.0	71.7
100	73.5	72.9	71.0	70.5	71.9	69.7	73.0	75.2	77.4	79.5	81.0	81.4	80.2	78.5	75.4	73.7	72.4	74.9	72.5	74.0
125	81.2	76.7	76.7	78.4	80.4	76.7	79.7	81.0	83.2	86.4	88.2	88.5	87.7	86.5	82.5	80.4	81.5	86.0	83.7	79.9
160	76.5	77.2	78.4	78.9	80.5	79.4	83.7	85.0	87.9	90.7	92.2	91.4	91.7	89.5	85.4	82.5	80.5	78.2	77.7	77.0
200	80.0	80.5	81.4	82.2	83.7	82.0	86.0	88.0	91.0	93.0	93.5	91.7	93.9	91.5	88.4	84.9	83.4	81.0	80.5	80.0
250	80.4	82.4	81.4	81.7	83.0	81.2	84.9	86.7	89.0	90.7	90.4	89.0	91.0	90.2	87.0	83.2	83.0	81.9	79.9	79.9
315	79.7	80.7	81.2	81.1	82.2	81.6	85.2	86.7	89.6	91.2	92.4	89.7	90.9	91.2	87.4	84.2	82.4	81.4	79.7	79.4
400	83.4	83.4	85.1	84.9	86.4	84.6	88.2	90.4	92.6	94.6	94.4	91.4	94.2	94.1	90.9	88.1	86.6	85.2	83.6	82.4
500	83.4	83.8	83.9	84.3	85.3	83.6	87.6	89.6	91.1	92.1	91.6	89.4	91.1	92.8	90.1	87.3	85.6	84.3	84.3	81.9
630	83.1	84.3	84.9	85.6	86.8	85.3	88.8	91.1	92.6	93.3	92.8	89.6	92.3	93.9	91.8	89.1	87.1	86.3	84.6	83.4
800	84.0	85.8	86.0	86.6	88.3	86.6	90.1	92.1	93.6	93.8	93.1	89.6	91.8	94.5	93.3	90.1	88.3	87.3	85.8	85.0
1 000	84.0	86.7	86.9	87.5	89.0	87.2	90.4	92.7	94.0	93.9	92.4	89.7	91.9	94.5	93.9	90.5	89.0	87.9	86.7	86.2
1 250	85.4	87.4	87.4	87.7	89.1	87.1	90.2	93.1	94.1	93.6	91.2	89.6	90.7	93.7	94.1	90.4	89.2	88.2	87.2	86.6
1 600	85.3	86.6	87.1	86.6	88.6	87.3	90.1	92.0	93.0	91.8	89.3	88.0	90.0	92.3	93.5	90.0	88.6	87.1	86.3	86.1
2 000	84.2	86.4	86.9	85.9	87.7	87.4	90.5	91.4	91.9	89.9	87.0	86.2	88.0	91.4	92.5	90.9	88.0	86.4	85.7	86.0
2 500	82.5	85.5	86.6	85.6	87.8	86.8	90.3	92.6	91.1	90.6	87.5	85.3	87.5	91.3	92.5	91.3	88.5	86.5	86.0	83.6
3 150	83.9	86.6	87.1	87.4	89.9	87.9	90.7	93.6	93.1	91.2	87.7	86.2	88.2	92.4	93.7	89.4	89.7	88.4	87.6	84.2
4 000	84.1	86.2	86.7	87.1	88.7	87.9	90.1	90.4	92.2	88.7	84.1	83.4	86.6	90.4	92.6	90.2	88.6	87.1	85.6	85.2
5 000	82.1	83.9	85.1	85.4	87.1	86.4	88.4	89.6	89.8	86.8	83.3	81.6	83.8	88.1	90.4	88.9	86.6	84.9	83.9	82.8
6 300	78.7	83.3	83.7	85.2	87.0	85.5	89.0	90.0	88.0	86.3	82.8	81.2	83.7	87.2	90.5	89.0	87.7	85.7	84.5	81.2
8 000	79.0	82.8	83.5	84.6	87.5	86.0	88.1	89.5	88.6	84.3	81.6	79.3	81.0	86.0	88.8	89.0	86.5	84.1	82.8	81.0
10 000	77.0	80.7	82.2	84.7	87.0	85.8	87.0	87.5	86.7	83.0	79.5	78.3	80.5	85.3	88.0	88.5	86.3	84.3	82.7	79.3
12 500	75.6	78.1	80.1	82.0	85.3	83.5	85.6	86.6	84.0	80.8	78.1	76.1	77.6	81.8	85.6	87.0	84.6	82.0	80.8	77.1
16 000	72.1	75.6	77.5	79.8	83.0	81.5	83.0	83.6	81.8	78.0	75.1	73.0	74.5	79.8	83.3	85.1	82.6	79.8	77.6	74.8
20 000	69.0	72.2	74.5	77.2	79.5	78.2	79.9	80.7	78.2	75.4	71.9	69.7	71.2	77.0	79.9	83.2	80.0	76.9	74.9	71.4
Overall	95.7	97.5	98.1	98.5	100.3	98.9	101.9	103.7	104.5	104.4	103.5	101.5	103.3	104.7	104.4	102.0	100.3	99.0	97.8	96.5

TABLE I. - Continued. ONE-THIRD-OCTAVE-BAND SOUND PRESSURE LEVEL ON 15.24-METER-RADIUS CIRCLE

FOR EXTERNALLY BLOWN FLAP WITH SEVEN-LOBE MIXER NOZZLE

[Sound pressure level referenced to 2×10^{-5} N/m^2. Data corrected for atmospheric attenuation (lossless).]

(s) Run 19. Nozzle alone; nozzle pressure ratio, 1.3; nozzle exhaust velocity, 206 m/sec; nozzle temperature, 291 K; ambient temperature, 279 K; relative humidity, 65 percent; barometric pressure, 99.7×10^3 N/m^2.

Frequency, Hz	Angle, deg																			
	15	35	55	70	85	100	115	125	135	145	155	165	205	215	230	250	270	290	310	330
	Sound pressure level, dB																			
50	66.5	67.3	66.8	67.0	68.2	66.2	68.5	70.7	71.8	73.7	75.2	76.5	76.2	73.5	70.7	69.2	68.2	67.3	66.5	66.3
63	67.2	66.8	67.8	67.5	68.3	66.7	70.3	71.7	72.7	74.2	74.8	77.5	75.7	74.2	71.5	70.0	69.7	68.0	66.5	66.2
80	69.2	69.3	69.3	67.5	69.2	66.7	70.7	71.7	72.5	73.5	74.8	75.3	75.8	74.2	72.7	71.7	71.2	70.2	70.5	70.0
100	72.0	70.9	69.0	68.4	69.7	66.9	70.7	72.4	73.5	75.7	76.9	78.0	77.2	75.5	72.2	71.2	71.2	73.9	72.4	72.2
125	80.9	76.0	75.5	77.0	79.2	75.5	77.9	79.5	81.2	83.9	85.7	85.4	86.2	84.5	80.0	79.2	81.0	86.5	83.4	79.4
160	73.4	74.2	75.7	76.7	78.2	76.7	81.0	81.9	84.4	87.2	88.2	88.0	88.4	86.5	83.4	79.9	77.9	76.2	75.4	73.7
200	76.4	76.9	78.5	78.5	80.4	78.7	83.0	84.7	87.2	88.9	89.4	88.0	89.7	88.0	84.9	82.0	79.9	78.4	77.0	76.5
250	77.2	78.5	78.2	78.9	79.7	77.7	81.4	83.9	85.2	87.0	86.2	84.9	87.4	86.2	83.9	80.4	79.7	78.7	76.7	76.2
315	76.6	77.1	77.4	78.2	79.1	78.1	82.2	82.9	84.7	86.4	87.7	85.4	86.6	86.6	83.7	81.4	79.4	78.2	76.6	76.1
400	79.6	79.9	81.7	81.7	82.7	80.9	84.7	86.4	87.9	89.7	89.2	86.7	89.7	89.7	86.6	84.1	83.1	81.9	80.4	78.9
500	79.1	79.8	80.3	80.4	81.4	80.1	83.3	85.4	86.6	87.4	86.8	85.4	86.6	88.3	85.9	83.4	81.9	80.3	80.1	78.1
630	78.9	79.9	81.1	81.9	83.1	81.4	84.1	86.9	87.9	88.8	87.8	85.8	87.8	89.4	87.6	84.6	83.6	82.4	80.8	79.4
800	79.6	81.3	82.3	83.0	84.5	82.8	85.8	87.8	89.0	89.1	88.6	85.5	87.5	90.1	88.8	86.3	84.3	83.1	81.8	81.0
1 000	79.7	82.0	83.0	83.5	85.0	83.4	85.9	88.5	89.2	89.0	88.4	85.5	87.0	90.0	89.5	86.4	84.9	84.0	82.9	82.0
1 250	80.7	82.9	83.4	83.7	85.1	83.4	85.9	88.6	89.2	88.7	87.2	84.7	86.7	89.9	89.4	86.1	85.2	83.9	83.2	82.4
1 600	80.8	82.3	82.8	83.0	84.6	83.5	85.5	87.3	88.1	87.3	84.8	83.6	85.3	88.5	88.6	85.6	84.5	83.0	82.1	82.0
2 000	79.5	81.7	82.7	81.7	83.2	83.0	85.7	86.4	87.0	85.2	82.7	81.2	83.7	86.9	87.9	86.4	83.7	82.0	81.4	81.4
2 500	77.6	81.0	82.0	81.5	83.3	82.6	85.5	88.0	86.3	86.0	83.0	80.6	82.6	86.6	87.6	87.0	83.8	82.0	81.5	79.5
3 150	79.4	82.4	82.9	83.2	85.6	83.4	86.4	88.4	88.1	86.7	83.6	81.4	84.1	87.6	88.7	84.9	85.4	84.1	83.4	80.4
4 000	79.2	81.7	82.7	82.9	84.6	83.6	85.7	85.9	87.4	83.9	79.6	77.9	82.2	85.7	87.9	85.4	83.9	82.9	81.6	80.6
5 000	77.3	79.1	80.9	81.4	82.9	81.9	84.1	84.9	85.1	81.8	78.4	76.4	79.4	83.6	85.4	84.9	82.3	80.8	80.3	78.4
6 300	74.2	78.7	79.5	80.8	83.2	81.5	84.3	85.3	83.7	81.5	78.7	76.0	79.2	82.2	85.8	85.0	83.5	81.5	80.2	76.2
8 000	74.5	77.8	79.0	80.6	83.6	82.0	84.1	86.1	84.5	79.3	77.5	74.3	76.8	81.1	84.8	85.0	83.0	80.6	79.0	76.3
10 000	72.3	76.0	78.2	81.0	83.0	82.3	83.2	84.0	82.7	78.7	75.3	73.2	76.2	80.3	84.2	84.3	82.7	80.5	78.8	74.8
12 500	71.1	73.3	75.8	78.1	81.5	79.5	81.3	82.8	79.8	76.6	73.8	71.0	73.6	77.5	81.5	83.3	81.1	77.8	76.6	72.6
16 000	67.3	70.5	73.0	76.1	78.6	77.6	78.8	79.6	78.0	74.0	70.5	67.8	70.3	75.5	79.0	81.3	78.8	75.8	74.1	70.3
20 000	64.4	67.9	70.0	73.4	75.2	74.2	75.7	76.9	74.4	70.7	67.7	64.9	67.2	72.7	75.4	78.9	76.2	72.7	70.7	66.9
Overall	91.6	93.2	94.2	94.7	96.4	95.0	97.6	99.4	99.9	99.9	99.1	97.4	99.1	100.5	100.0	98.0	96.4	95.4	94.1	92.5

TABLE I. - Concluded. ONE-THIRD-OCTAVE-BAND SOUND PRESSURE LEVEL ON 15.24-METER-RADIUS CIRCLE FOR EXTERNALLY BLOWN FLAP WITH SEVEN-LOBE MIXER NOZZLE

[Sound pressure level referenced to 2×10^{-5} N/m^2. Data corrected for atmospheric attenuation (lossless).]

(t) Run 20. Nozzle alone; nozzle pressure ratio, 1.2; nozzle exhaust velocity, 174 m/sec; nozzle temperature, 292 K; ambient temperature, 279 K; relative humidity, 65 percent; barometric pressure, 99.7×10^3 N/m^2.

Frequency, Hz	Angle, deg																		
	15	35	55	70	85	100	115	125	135	145	155	165	205	215	230	250	270	290	310	330
	Sound pressure level, dB																			
50	62.7	63.0	62.5	63.3	63.8	61.8	65.5	66.0	68.5	70.0	70.8	71.8	71.2	69.8	67.3	64.7	64.3	63.7	62.3	62.7
63	63.8	65.0	65.5	65.5	65.5	64.5	67.3	68.8	69.2	70.8	71.3	72.5	71.8	70.3	68.3	66.8	66.5	65.8	63.5	63.8
80	67.5	67.3	66.0	66.0	66.0	63.8	68.0	70.0	69.7	71.2	70.5	71.2	71.8	71.0	70.5	69.3	69.7	69.5	68.7	69.3
100	70.5	68.9	66.7	66.7	67.9	64.3	66.5	69.2	70.5	71.5	73.0	72.4	72.9	72.7	69.0	68.2	68.5	72.7	71.0	70.7
125	80.9	75.7	73.9	76.9	79.0	73.3	75.3	78.5	79.7	82.0	83.0	82.2	84.0	82.9	78.0	77.5	80.2	86.4	83.5	79.4
160	70.0	70.9	72.4	72.9	74.9	73.0	79.5	79.0	80.5	82.2	83.4	83.0	83.2	82.0	79.7	76.2	74.0	72.7	72.4	70.0
200	72.5	73.0	74.4	75.0	76.2	74.8	80.0	81.2	82.9	84.0	84.5	82.4	84.2	83.7	81.2	78.4	75.7	74.5	73.0	72.5
250	73.5	73.9	74.2	74.4	76.2	75.4	78.7	80.4	81.4	82.5	81.7	80.0	81.9	81.2	79.7	76.4	75.7	74.5	72.5	72.2
315	72.9	73.1	73.2	73.9	74.4	73.4	77.4	78.1	79.4	80.2	81.4	78.9	80.9	81.1	78.4	77.1	74.2	73.7	73.1	72.2
400	75.1	75.7	76.9	76.7	77.7	76.4	79.9	81.2	82.6	84.1	83.6	80.4	83.7	83.2	81.7	79.4	78.1	77.1	76.1	74.9
500	75.3	75.4	75.4	75.4	76.1	74.9	77.9	79.4	80.3	80.8	80.8	78.3	80.8	81.9	79.6	78.1	76.6	75.8	76.4	74.1
630	74.6	74.8	75.8	76.6	77.4	75.8	78.8	80.9	81.6	82.4	81.4	79.4	81.8	83.1	81.1	79.3	77.8	76.8	75.4	74.4
800	75.1	76.1	76.8	77.5	78.6	77.0	80.0	81.8	82.5	82.6	82.1	79.5	81.1	83.6	82.5	80.1	78.6	77.8	76.3	75.5
1 000	74.5	76.4	77.2	77.7	79.0	77.0	79.7	82.0	82.7	82.4	82.0	79.2	80.4	83.7	82.7	80.2	78.9	77.9	77.2	76.2
1 250	77.1	77.7	77.9	78.1	79.2	77.1	79.9	81.9	82.7	82.1	81.4	78.4	79.7	83.4	83.2	80.1	79.2	78.2	78.1	77.2
1 600	76.3	76.3	77.0	77.1	78.5	76.6	79.3	80.6	81.6	80.5	79.0	76.6	78.5	82.1	82.0	79.3	78.5	77.0	76.8	76.6
2 000	74.2	76.4	76.4	75.4	77.2	76.0	79.2	79.9	80.2	78.5	76.5	74.5	76.5	80.4	80.7	79.7	77.0	76.4	75.9	77.4
2 500	71.8	74.6	75.5	75.0	77.0	75.3	79.1	81.0	79.3	79.1	76.5	73.6	75.5	80.3	81.1	80.6	77.6	76.1	75.8	73.8
3 150	72.7	76.2	76.4	76.9	79.1	76.7	79.7	82.2	81.2	79.9	76.7	74.6	77.1	81.1	82.7	78.4	78.7	77.9	77.2	74.2
4 000	73.1	75.1	76.4	76.7	77.9	76.7	79.2	79.2	80.9	77.4	72.9	71.4	75.4	79.6	81.7	78.9	77.4	76.9	75.2	74.4
5 000	70.8	72.8	74.4	75.1	76.4	74.9	77.8	78.4	78.8	75.1	72.3	69.9	72.3	76.9	79.6	78.6	75.9	74.6	73.4	72.3
6 300	67.8	72.2	73.0	74.7	77.0	74.5	78.7	79.3	77.3	74.8	71.8	69.2	72.3	76.0	80.2	79.0	77.3	74.8	73.8	70.3
8 000	68.3	72.3	73.3	74.8	78.1	76.1	79.6	81.1	79.3	73.8	71.5	68.5	70.5	75.3	80.0	79.8	77.5	74.0	72.8	70.5
10 000	66.0	70.0	71.8	74.5	77.5	75.7	78.5	78.8	77.0	72.7	69.2	67.2	69.7	74.7	79.0	79.0	77.2	74.0	72.7	68.8
12 500	64.5	67.1	69.1	71.1	75.0	72.5	76.0	77.1	74.0	70.3	67.3	64.8	67.1	71.3	76.0	76.8	74.8	71.1	69.5	66.1
16 000	60.6	64.3	66.8	68.8	72.5	70.5	73.5	74.0	72.0	67.8	64.6	61.5	64.0	69.5	73.6	75.1	72.6	68.3	67.5	63.8
20 000	57.7	61.2	63.7	66.4	68.9	66.7	70.0	70.7	68.2	64.9	61.2	57.9	60.5	66.4	69.5	72.4	69.5	65.4	64.0	60.4
Overall	87.6	88.1	88.6	89.2	90.9	89.0	92.3	93.7	94.1	94.0	93.6	91.6	93.4	94.7	94.2	92.3	90.0	91.0	89.6	87.9

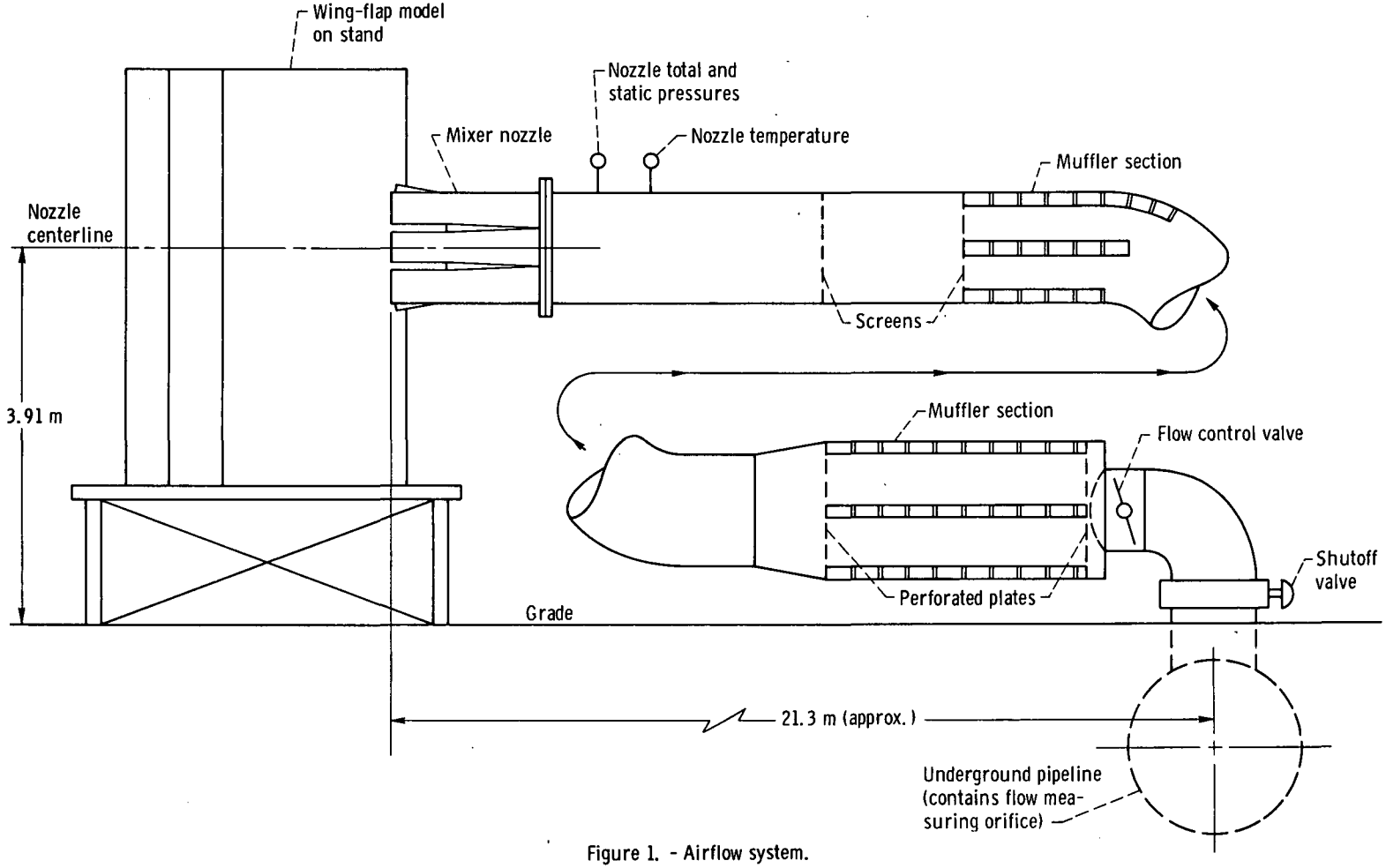
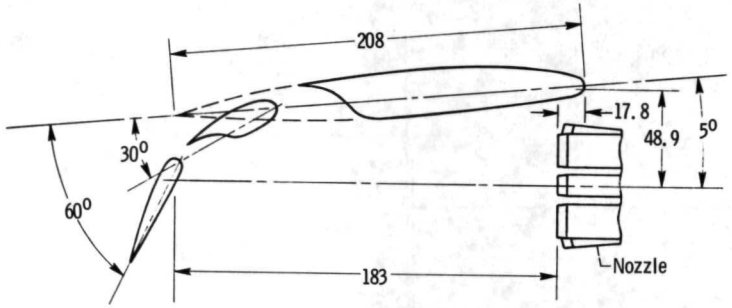
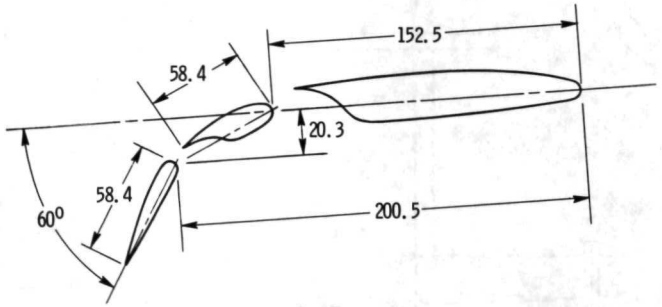


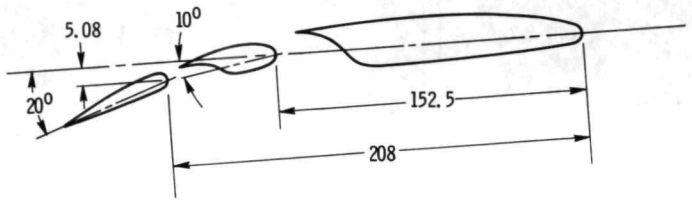
Figure 1. - Airflow system.



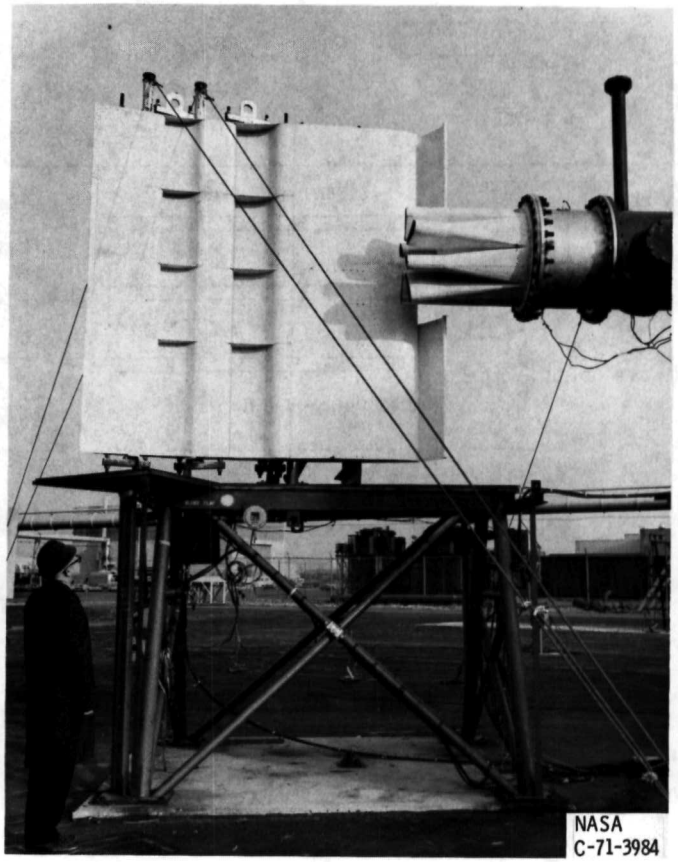
(a) Wing and nozzle orientation.



(b) 30°-60° Flap setting.



(c) 10°-20° Flap setting.



(d) Test installation.

Figure 2. - Configuration and dimensions of externally blown flap model. (All dimensions in centimeters.)

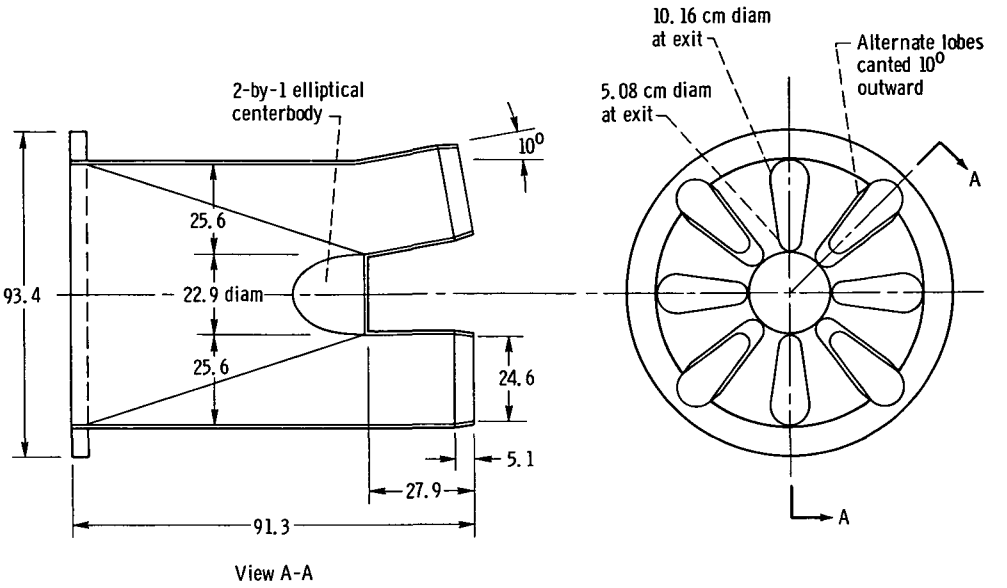


Figure 3. - Configuration and dimensions of mixer nozzle. (All dimensions in centimeters.)

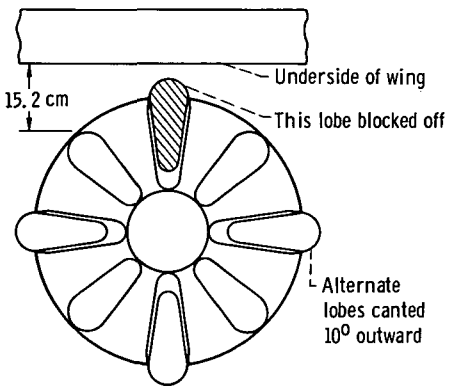


Figure 4. - Position of mixer nozzle relative to wing.
View is at exit plane of nozzle looking upstream.

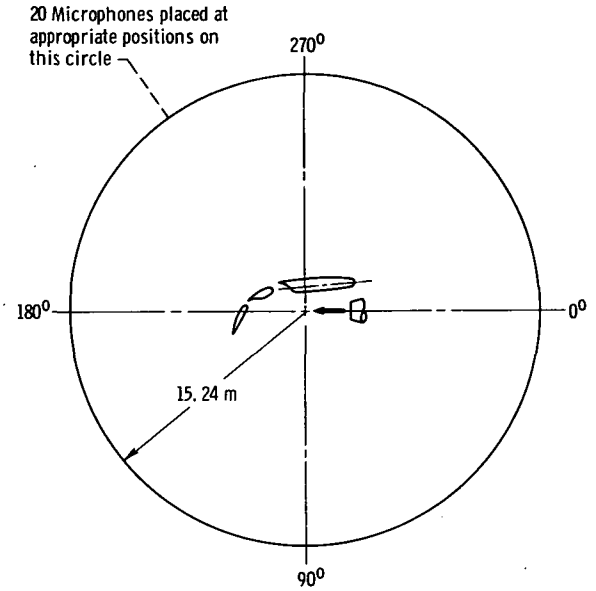


Figure 5. - Microphone layout.

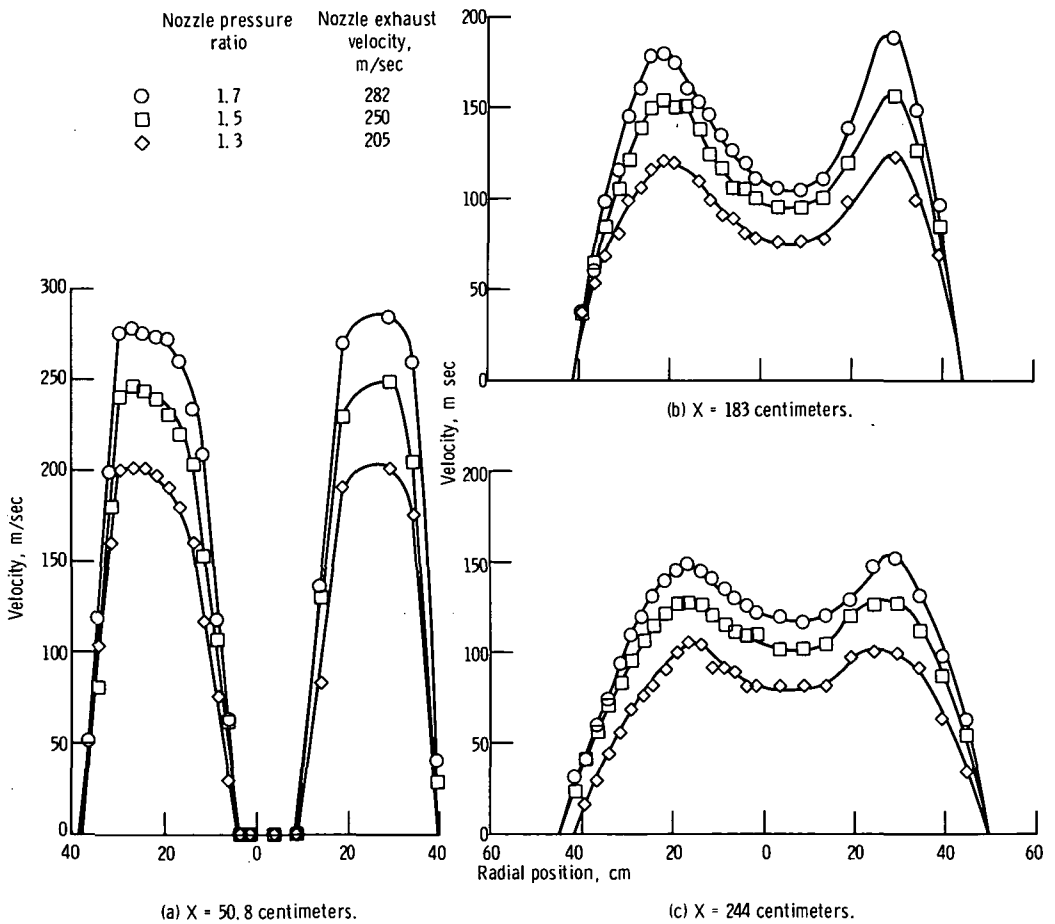


Figure 6. - Velocity profiles across straight lobes of seven-lobe mixer nozzle at various distances X downstream of the nozzle exit (wing removed).

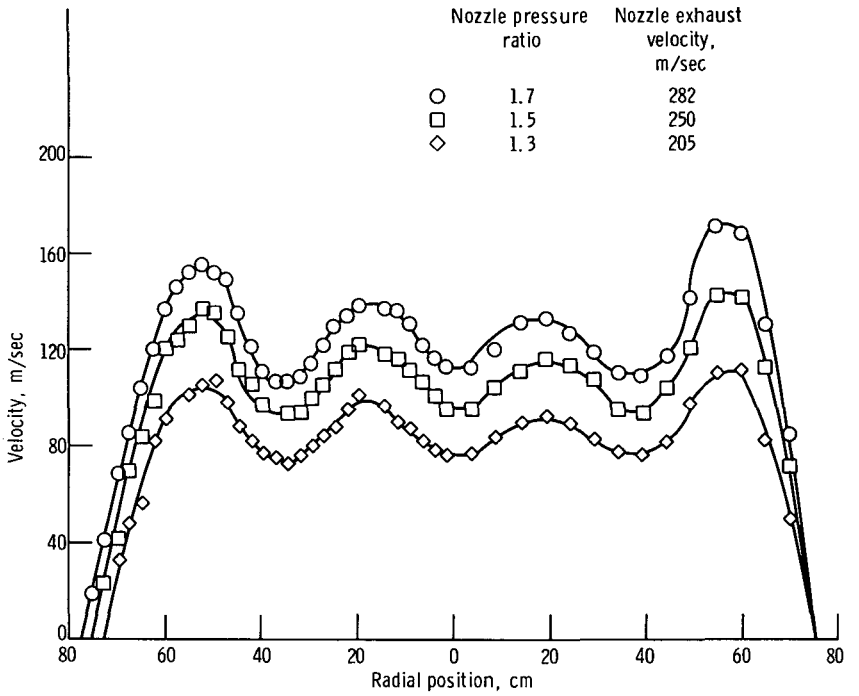


Figure 7. - Velocity profiles across canted lobes of seven-lobe mixer nozzle at a distance of 183 centimeters downstream of nozzle exit (wing removed).

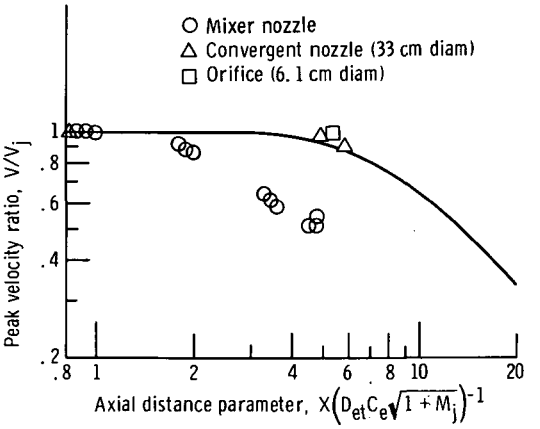
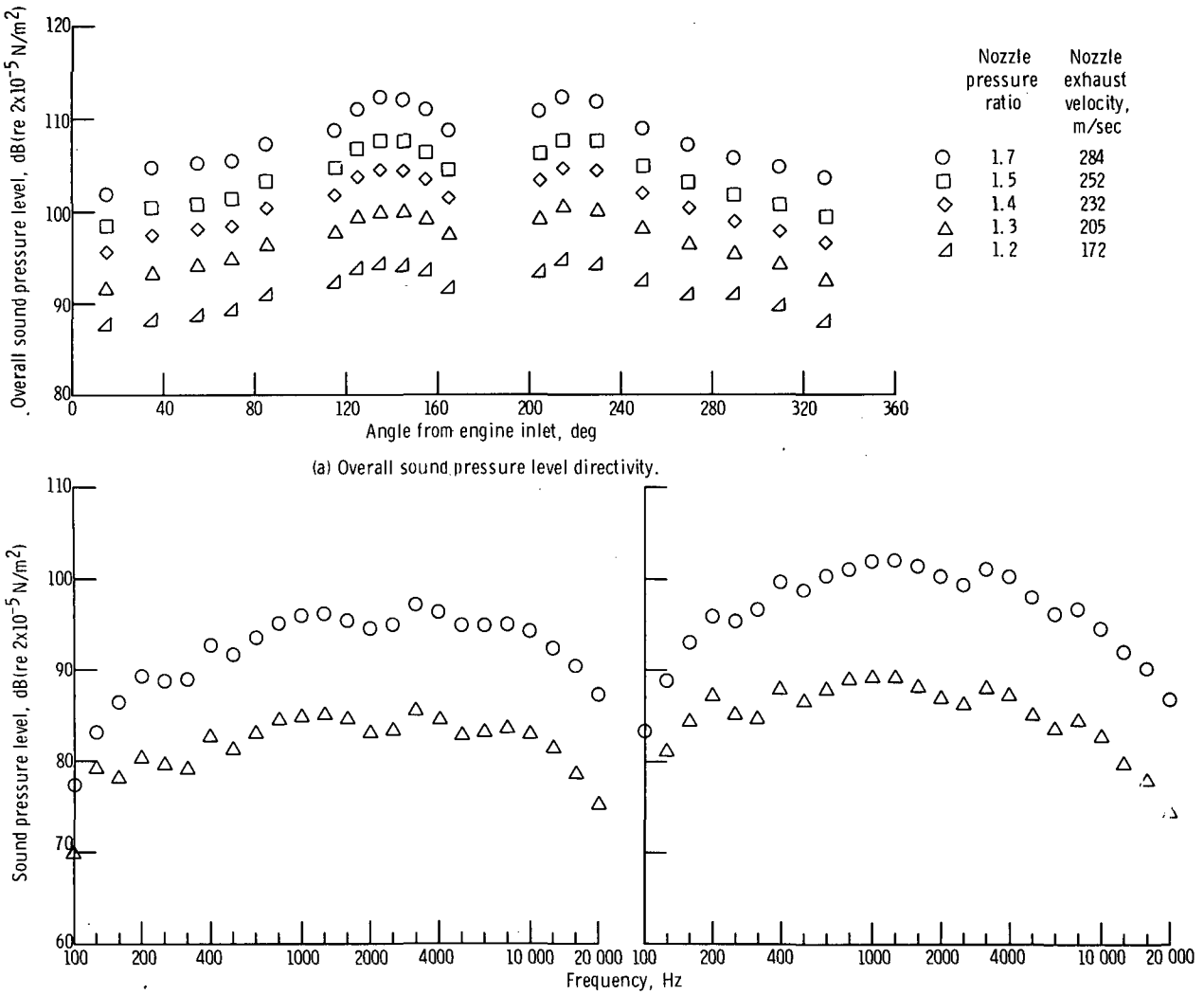


Figure 8. - Comparison of velocity decay for a mixer nozzle, a standard single convergent nozzle, and an orifice.



(a) Overall sound pressure level directivity.

(b) Sound pressure level 1/3-octave spectra at 85°.

(c) Sound pressure level 1/3-octave spectra at 135°.

Figure 9. - Noise data for mixer nozzle alone at various nozzle pressure ratios. Microphone radius, 15.24 meters.

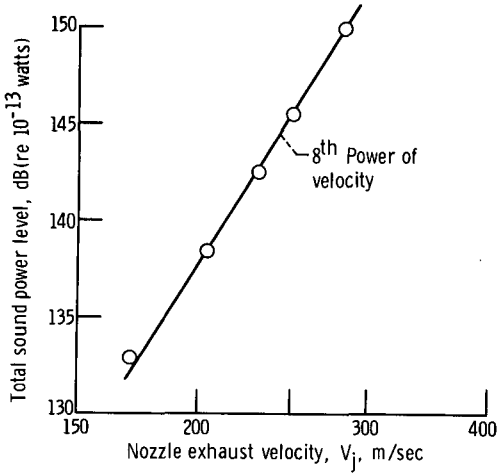
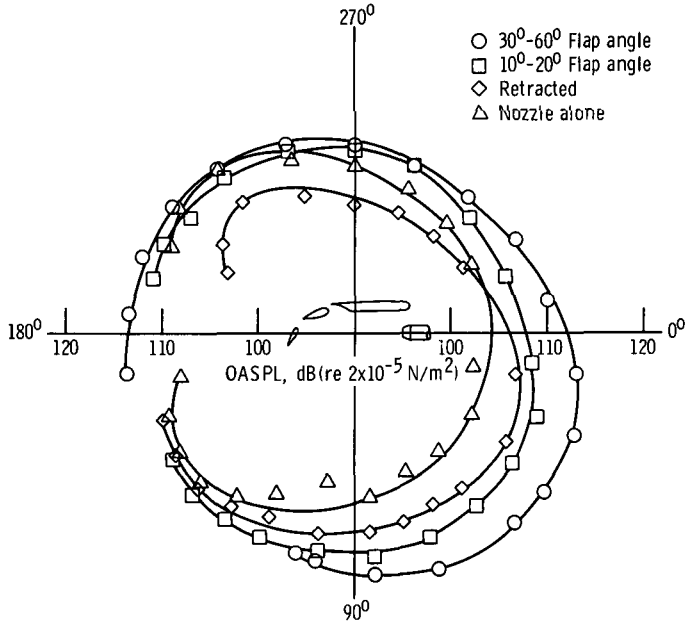
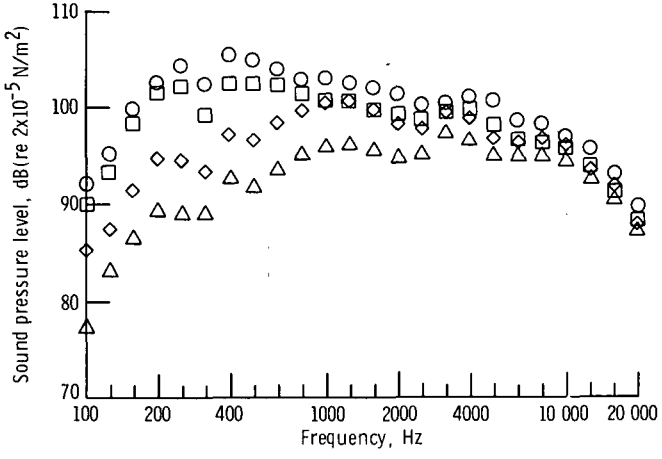


Figure 10. - Variation of total sound power level with nozzle exhaust velocity for seven-lobe mixer nozzle alone.



(a) Overall sound pressure level directivity.



(b) Sound pressure level 1/3-octave spectra at 85^0.

Figure 11. - Comparison of noise data for mixer nozzle with various flap angles and mixer nozzle alone. Nozzle pressure ratio, 1.7; nozzle exhaust velocity, 284 meters per second; microphone radius, 15.24 meters.

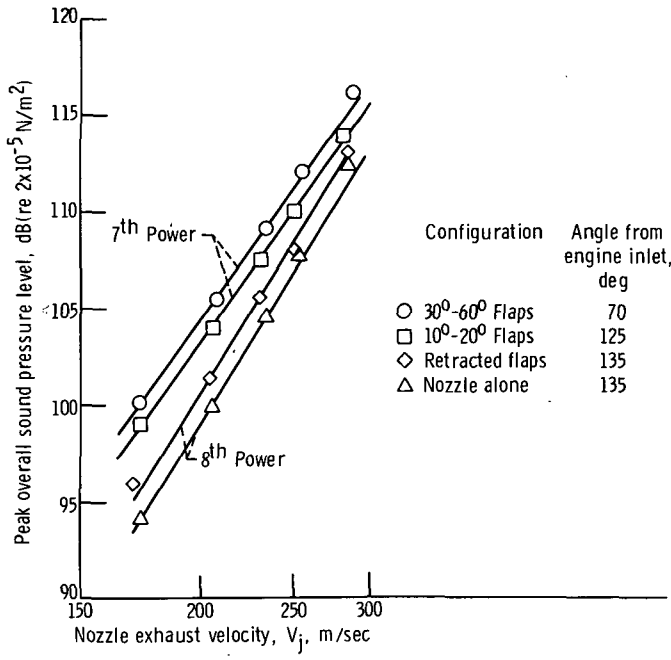


Figure 12. - Variation of peak overall sound pressure level with nozzle exhaust velocity. Microphone radius, 15.24 meters.

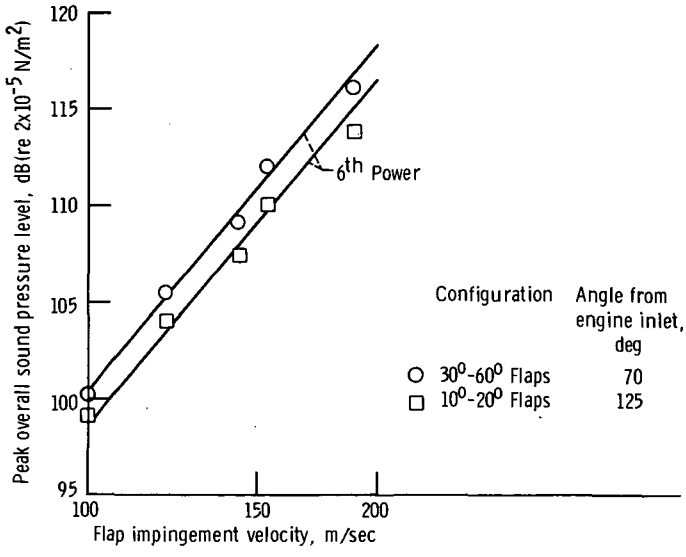
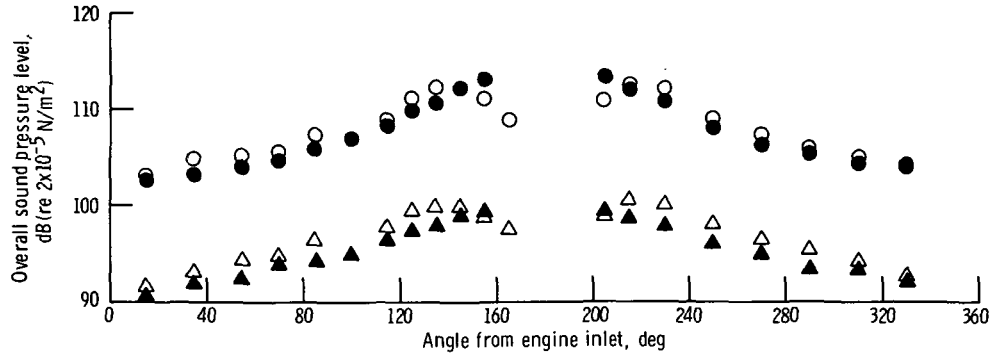
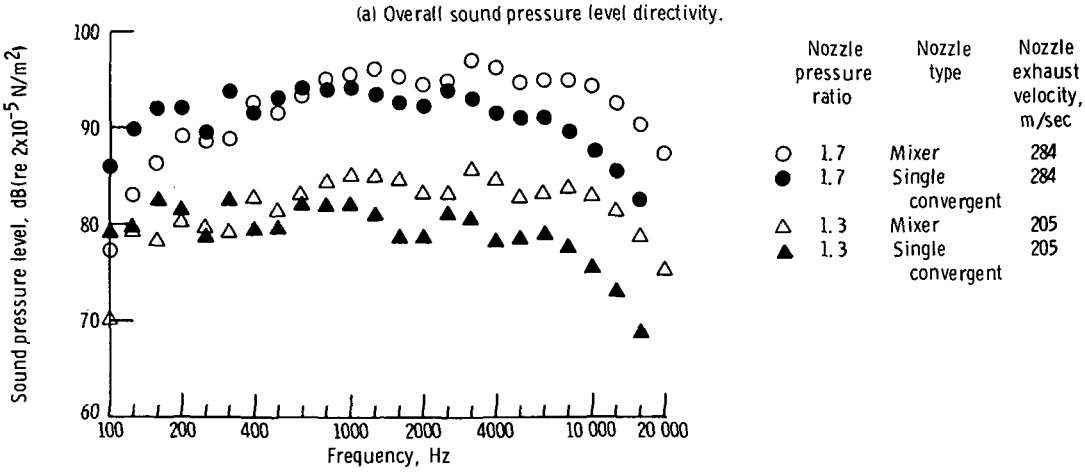


Figure 13. - Variation of peak overall sound pressure level with flap impingement velocity. Microphone radius, 15.24 meters.

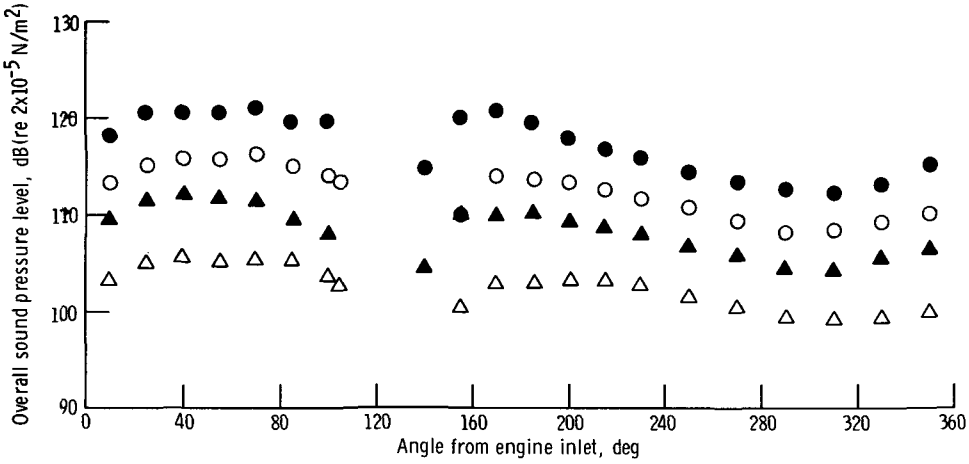


(a) Overall sound pressure level directivity.

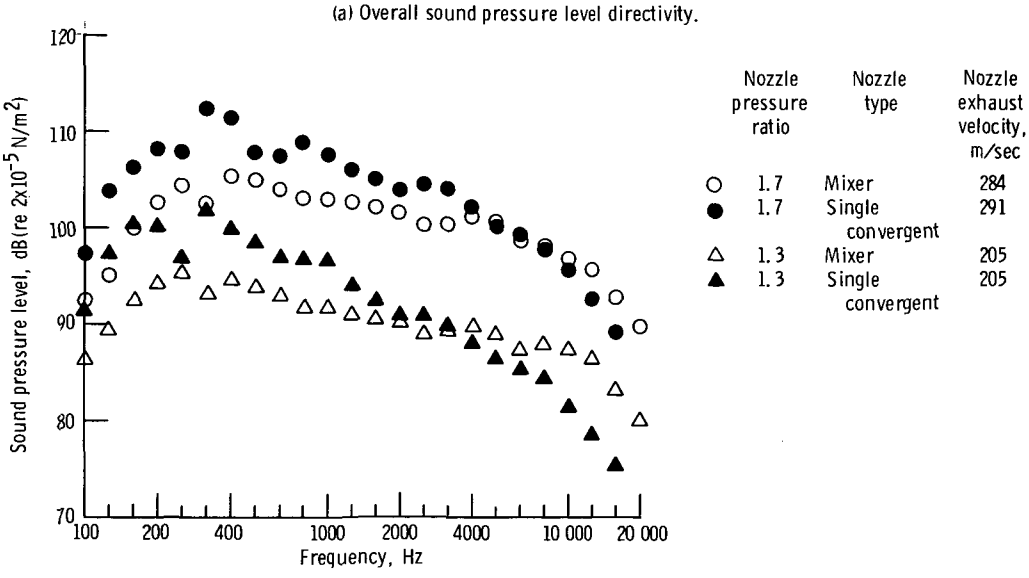


(b) Sound pressure level 1/3-octave spectra at 85°.

Figure 14. - Comparison of noise data for mixer nozzle alone and 33-centimeter-diameter single convergent nozzle alone. Microphone radius, 15.24 meters.

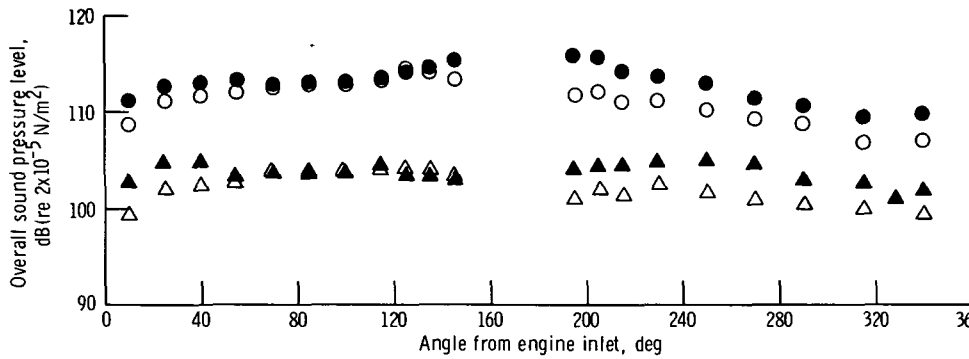


(a) Overall sound pressure level directivity.

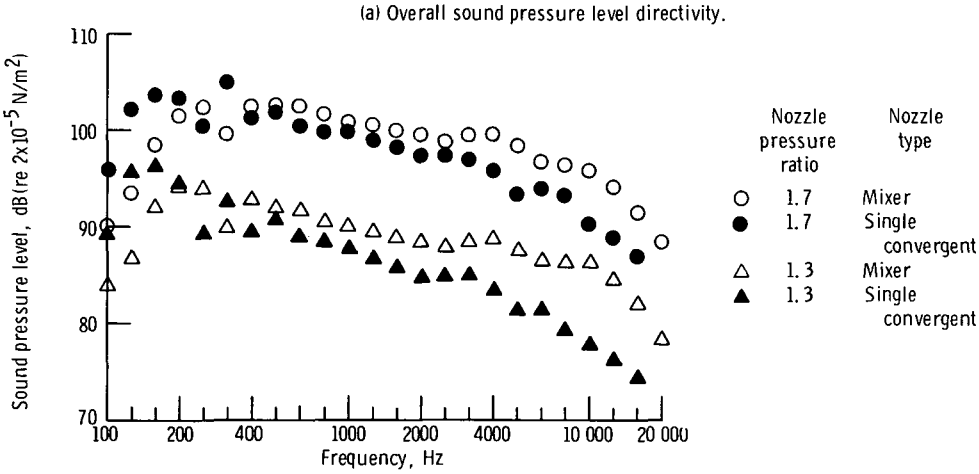


(b) Sound pressure level 1/3-octave spectra at 85^0.

Figure 15. - Comparison of noise data for mixer nozzle and standard single convergent nozzle, with 30^0-60^0 flap setting. Microphone radius, 15.24 meters.

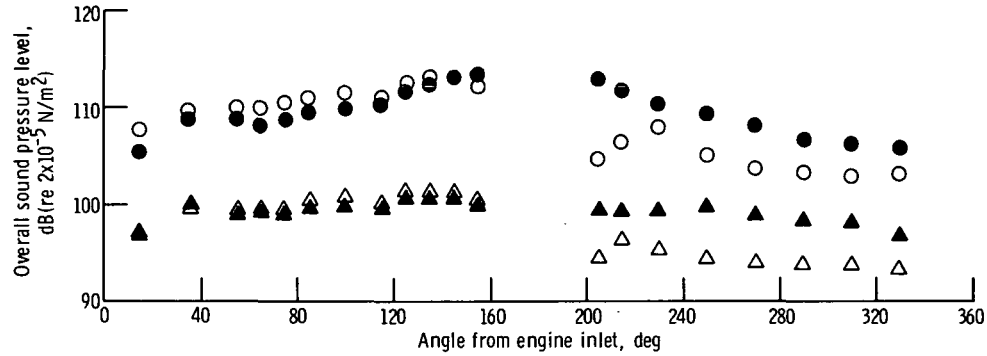


(a) Overall sound pressure level directivity.

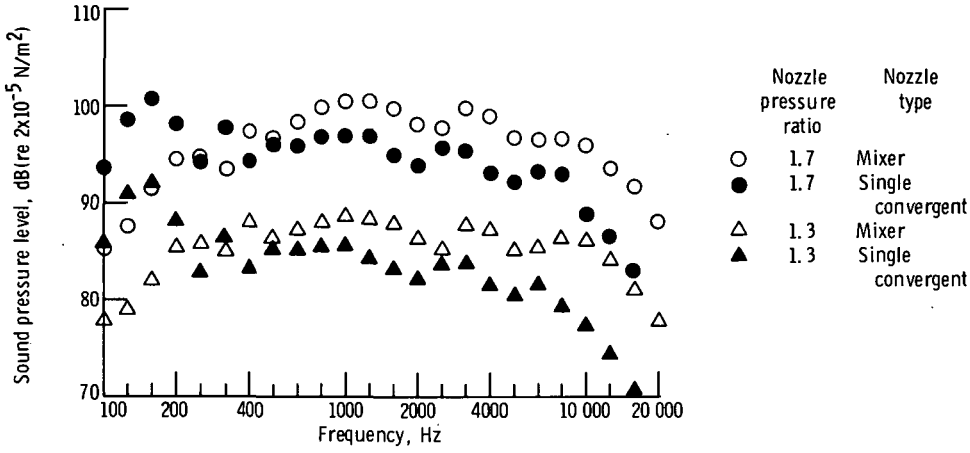


(b) Sound pressure level 1/3-octave spectra at 85°.

Figure 16. - Comparison of noise data for mixer nozzle and standard single convergent nozzle, with 10°-20° flap setting. Microphone radius, 15.24 meters.



(a) Overall sound pressure level directivity.



(b) Sound pressure level 1/3-octave spectra at 85°.

Figure 17. - Comparison of noise data for mixer nozzle and standard single convergent nozzle, with retracted flap setting. Microphone radius, 15.24 meters.

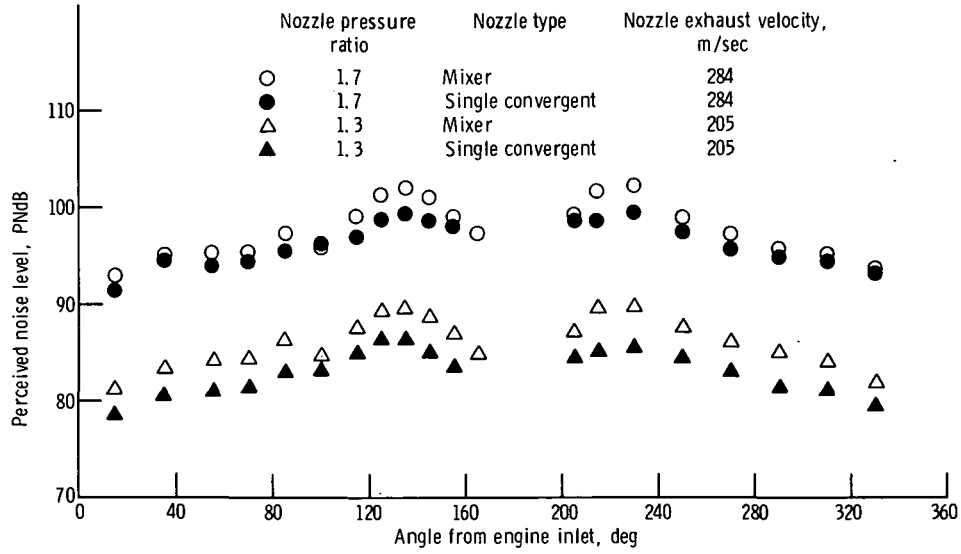


Figure 18. - Comparison of perceived noise level directivity pattern at 152.4 meters for mixer nozzle alone and standard single convergent nozzle alone.

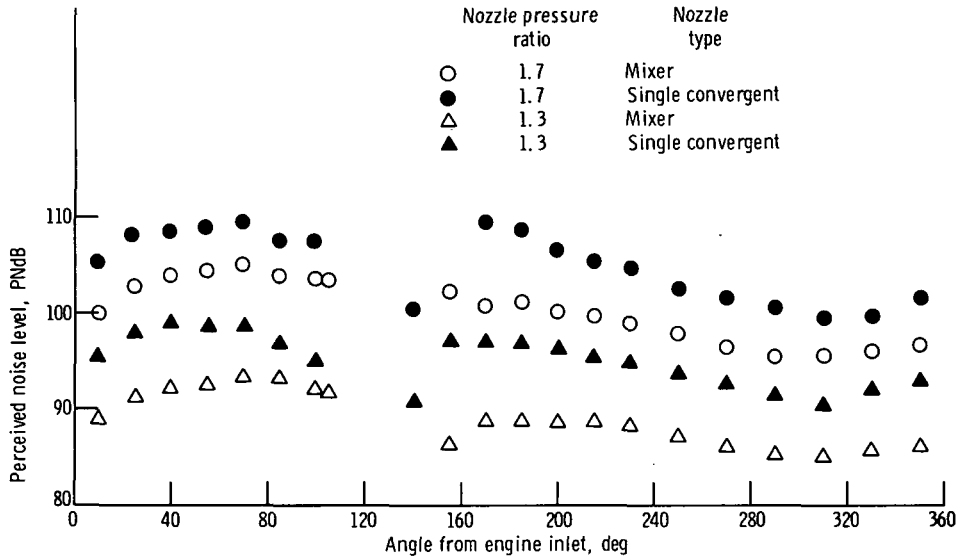


Figure 19. - Comparison of perceived noise level directivity pattern at 152.4 meters for mixer nozzle and standard single convergent nozzle, with 30^0-60^0 flap setting.

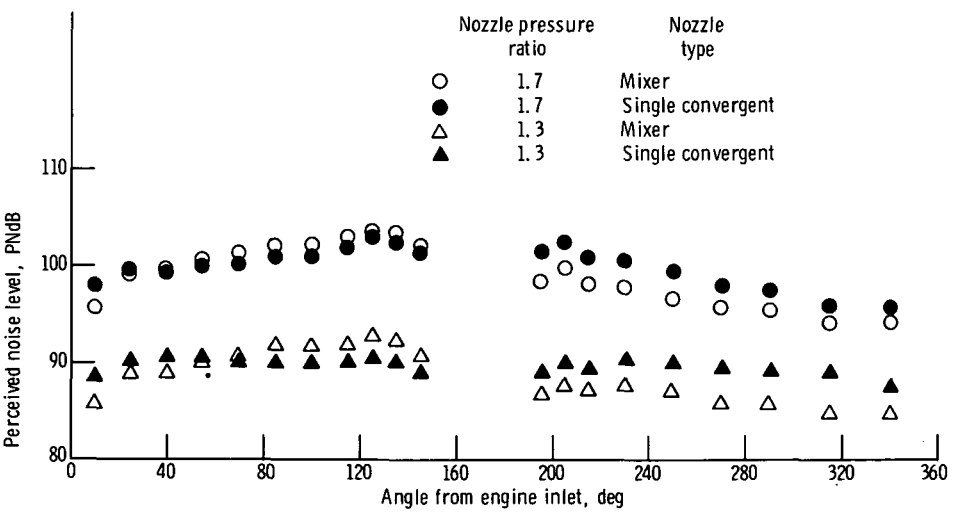


Figure 20. - Comparison of perceived noise level directivity pattern at 152.4 meters for mixer nozzle and standard single convergent nozzle, with 10^0-20^0 flap setting.

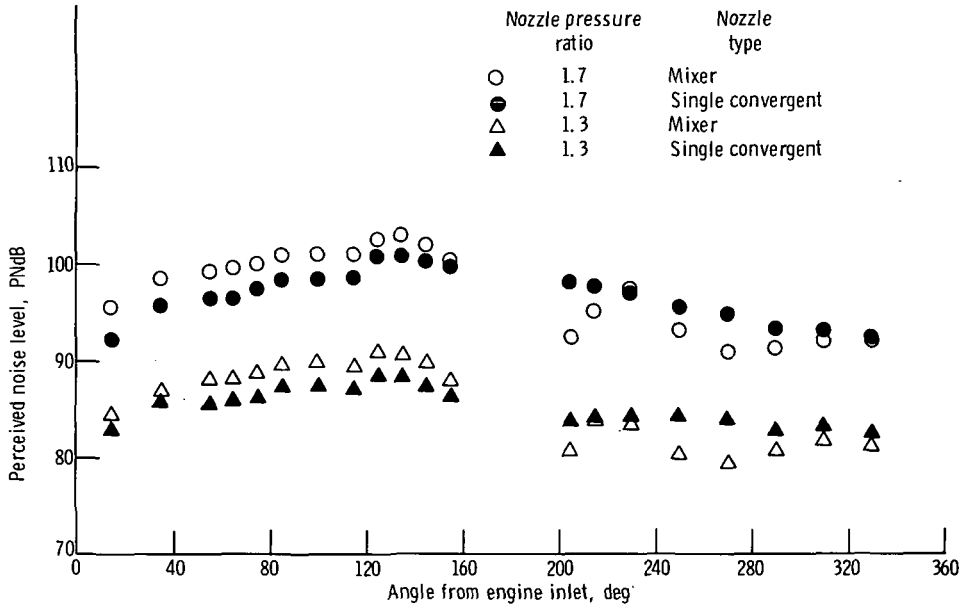
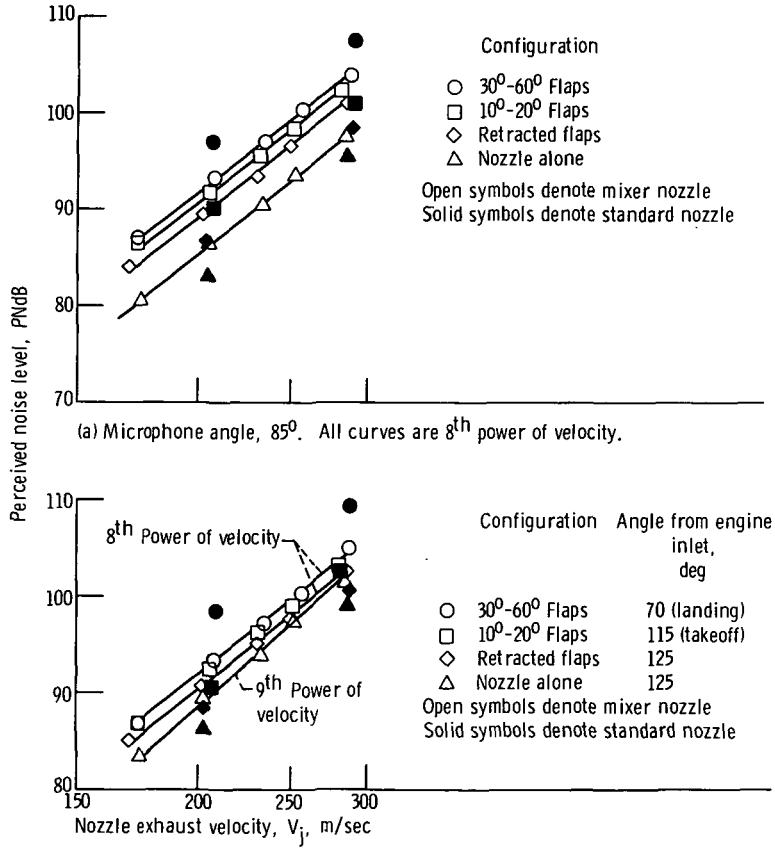


Figure 21. - Comparison of perceived noise level directivity pattern at 152.4 meters for mixer nozzle and standard single convergent nozzle, with retracted flap setting.



(a) Microphone angle, 85°. All curves are 8th power of velocity.

(b) Microphone angle producing flyover maximum.

Figure 22. - Perceived noise level at 152.4 meters as function of nozzle exhaust velocity for various configurations.

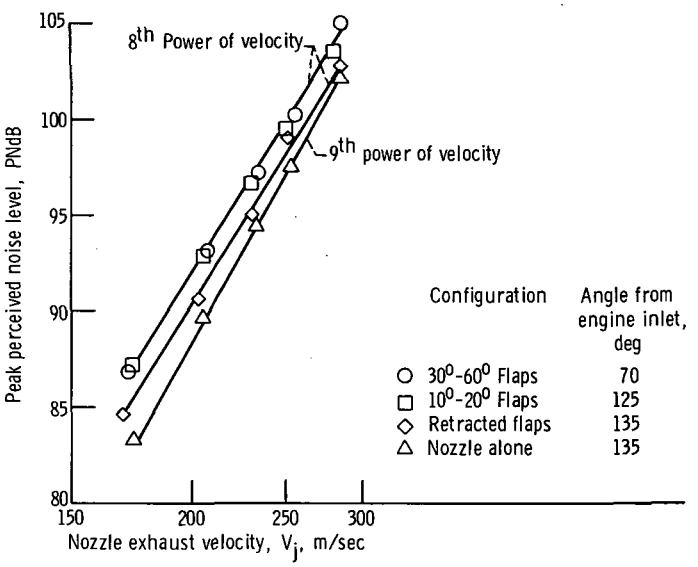


Figure 23. - Variation of peak perceived noise level at 152.4 meters with nozzle exhaust velocity.

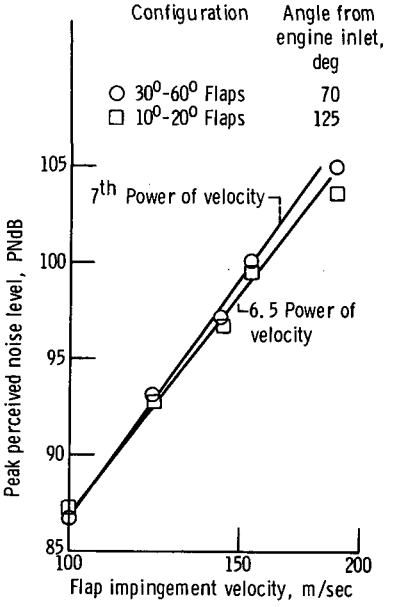
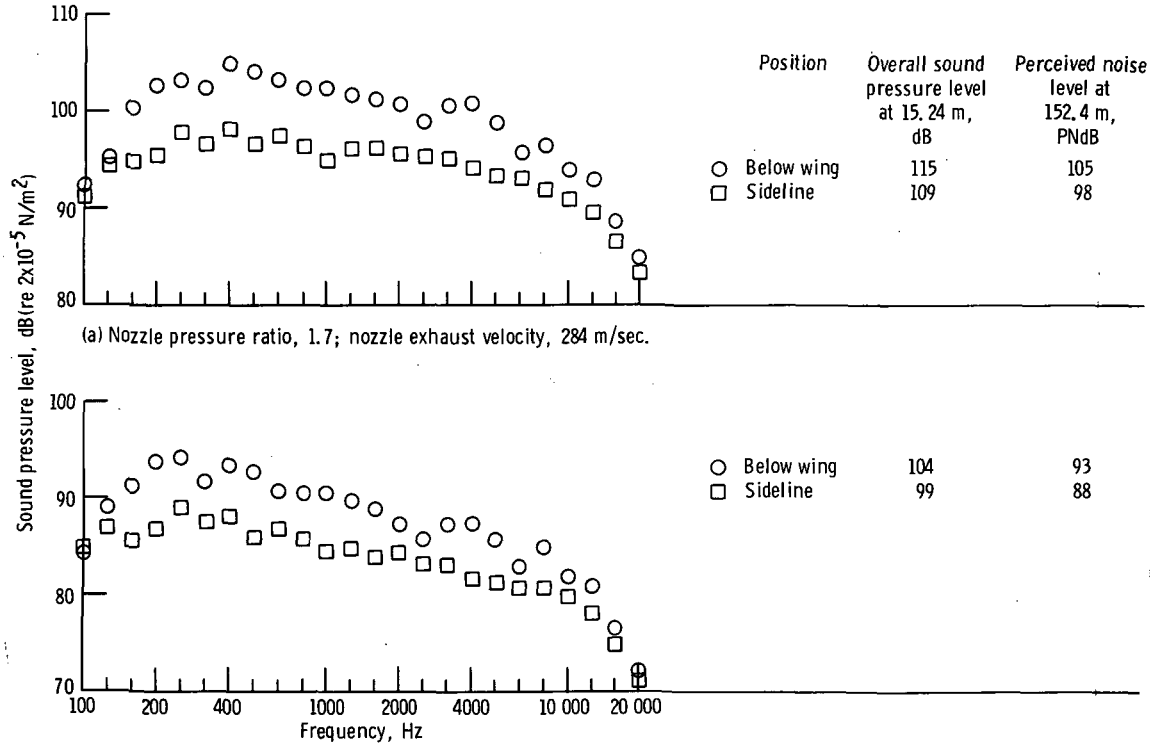


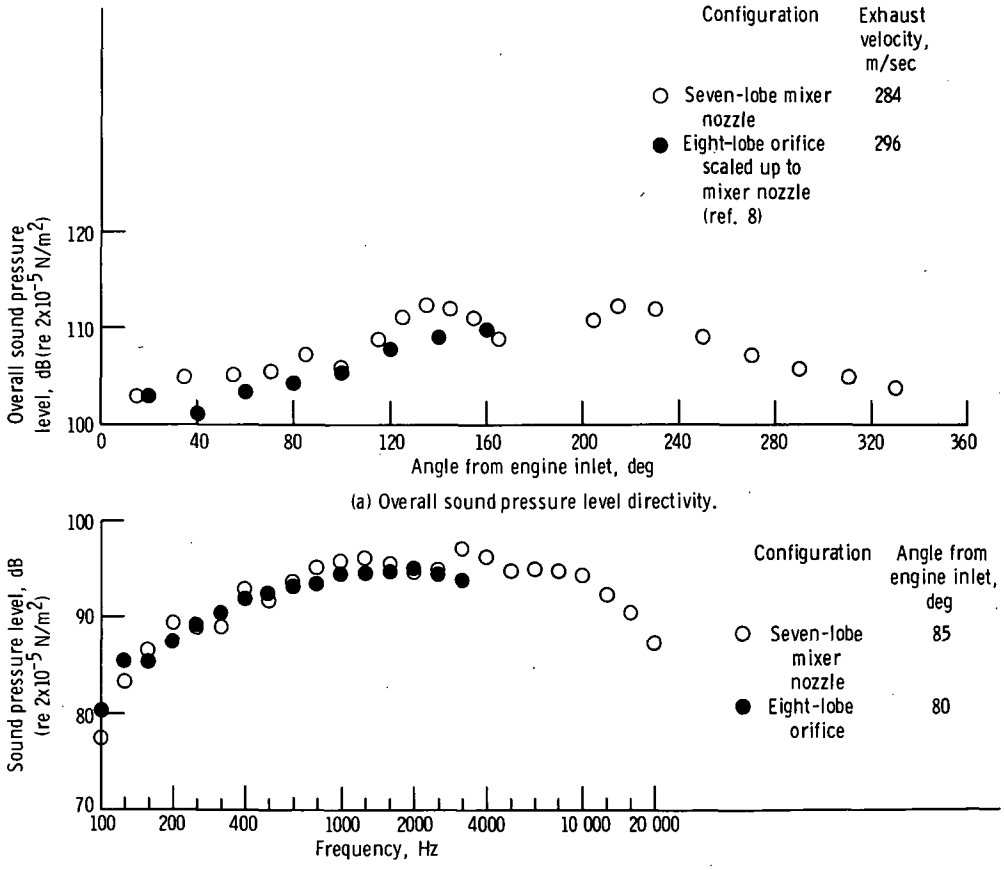
Figure 24. - Variation of peak perceived noise level at 152.4 meters with flap impingement velocity.



(a) Nozzle pressure ratio, 1.7; nozzle exhaust velocity, 284 m/sec.

(b) Nozzle pressure ratio, 1.3; nozzle exhaust velocity, 205 m/sec.

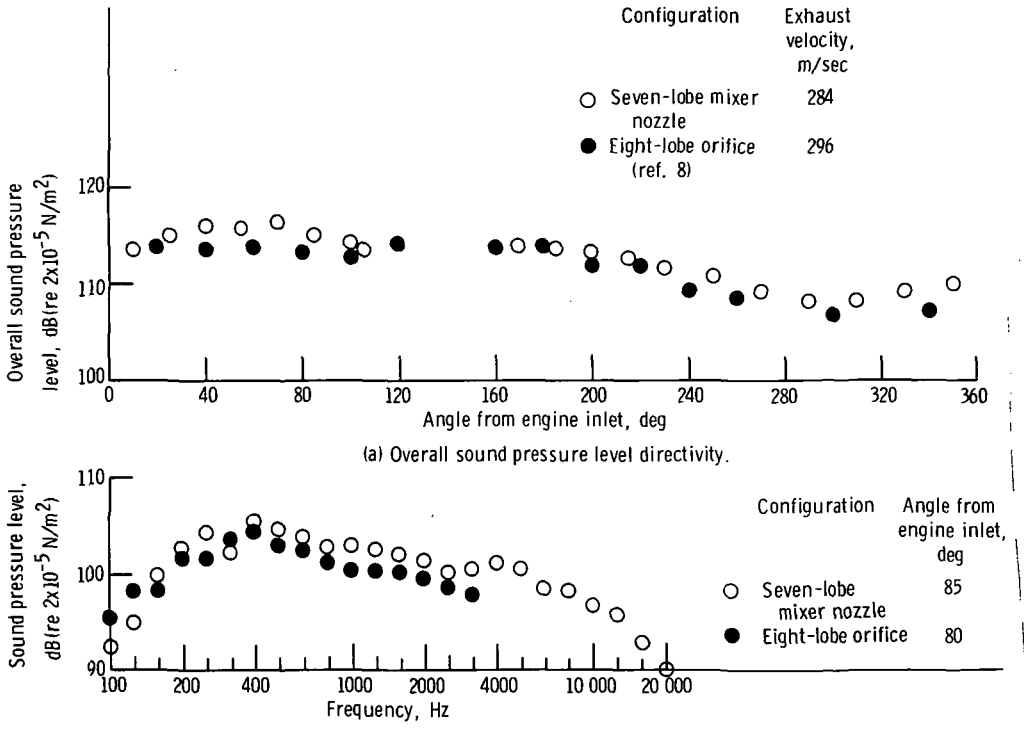
Figure 25. - Comparison of sound pressure level 1/3-octave spectra at 15.24 meters below the wing and 15.24 meters sideline distance for mixer nozzle with 30^0-60^0 flaps.



(a) Overall sound pressure level directivity.

(b) Sound pressure level 1/3-octave spectra.

Figure 26. - Comparison of noise data for mixer nozzle alone and small-scale eight-lobe orifice model alone. Microphone radius, 15.24 meters.



(a) Overall sound pressure level directivity.

(b) Sound pressure level 1/3-octave spectra.

Figure 27. - Comparison of noise data for mixer nozzle and small-scale eight-lobe orifice model, with 30^{o}-60^{o} flap setting. Microphone radius, 15.24 meters.

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